FRUITS & NUTS WEST

FUNGICIDE BENEFITS ASSESSMENT

National Agricultural Pesticide Impact Assessment Program (NAPIAP)

FUNGICIDE BENEFITS ASSESSMENT

FRUIT AND NUT CROPS - WEST

January, 1991

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This Report Represents a Portion of the USDA/States
National Agricultural Pesticide Impact Assessment Program (NAPIAP)
Fungicide Assessment Project

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PREFACE

Plant diseases affect all the major food crops world-wide and must be controlled to prevent significant production losses and maintain food quality for animals and humans. In addition, fungicides are a necessary factor in maintaining the availability of fiber and landscape improvements ranging from forest management to enhancements through the use of ornamentals. Agricultural fungicides are a significant component in effective disease control and are critical to plant health management systems. Fungicides provide benefits to producers as well as consumers and to local as well as national economies. Farmers benefit from the prevention of yield losses, improved crop quality, enhanced market opportunities, facilitation of farmwork and harvest. Consumers also benefit from an ample, varied, safe, healthy and inexpensive food supply that is available throughout the year.

This is one of 11 separate reports that assessed the beneficial aspects of fungicide use in U.S. agriculture. The 11 reports, all using a commodity approach in evaluating fungicide use, comprise the Fungicide Benefits Assessment. This assessment represents one part of the USDA/States National Agricultural Pesticide Impact Assessment Program's Fungicide Assessment Project. The two other parts deal with (a.) a treatise examining the health and environmental factors associated with the agricultural use of fungicides, and (b.) an assessment of the status as well as the management strategies for fungal resistance to fungicides in the U.S.

The 11 Fungicide Benefits Assessment reports were prepared by a team of scientists (team leaders). The team leaders and the listing of their reports (by commodity) in the Fungicide Benefits Assessment are as follows:

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January, 1991

NAPIAP Fungicide Assessment Project

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California	Themis Michailides	Pistachio
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	R. Michael Davis	Citrus
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Hawaii	Barry M. Brennan	Tropical Fruits
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Oregon	Jay W. Pscheidt	Tree Fruit
Utah	Sherman V. Thomson	Tree Fruit
Washington	Peter R. Bristow	Small Fruit
	Ralph S. Byther	Small Fruit
	Gary G. Grove	Tree Fruit

Benefits of Fungicides Used on Fruit and Nut Crops Grown in the Western United States.

The eighteen crops or crop groupings covered in this report and grown commercially in the Western U.S. require fungicide applications ranging from 1 to 14 per growing season for protection against diseases. Each crop is affected by several diseases requiring the use of several fungicides and/or fungicide combinations. In the absence of satisfactory biological or cultural control, loss of the currently used fungicides would have a significant impact in reducing yields, thus, increasing costs to consumers of fresh fruit and nut products. While Integrated Pest Management (IPM) research has, in many instances, led to reduced fungicide usage on some crops grown in the Western U.S., much remains to be learned from studies dealing with each crop and each pathogen. In general, growers have quickly adopted new information regarding changes in control strategies brought about by IPM research or research further identifying the biology of pathogens and epidemiology of diseases. In most instances, growers have been able to reduce fungicide usage and are eager to reduce usage further.

Strains of some pathogens attacking fruit and nut crops have developed tolerance to the benzimidazole, dicarboximide and demethylation inhibiting fungicides. While fungicides in these groups are still useful products, their use must be in combination with products of differing chemistry. Use, generally, is by alternating or tank-mixing products. Where resistance to fungicides occurs, rates are generally reduced, spray intervals may be shortened and/or the number of applications may be restricted. In recent years, fungicide development has been in the direction of materials which attack single rather than multiple sites. Though these products are highly effective and require only relatively small amounts to give commercial control, their continued singular use without the benefit of broad-spectrum protective materials such as captan, mancozeb, sulfur, and chlorothalonil will almost assuredly lead to reduced sensitivity in various pathogen populations and lead to ineffective use.

Fungicide Benefits on Almonds (*Prunus amygdalus*)

Almond production acreage in the U.S. is largely confined to California. There are approximately 450,000 acres planted to almond of which 402,000 acres were harvested in 1988.

Several major diseases are of concern to almond growers. These include:

Disease	Cause
Brown rot	(*Monilinia fructicola*)
Blossom blight	(*Monilinia fructicola*)
Fruit rot	(*M. laxa*)
Green fruit rot	(*Botrytis cinerea* & *Whetzelinia sclerotiorum*)
Shothole	(*Stigmina carpophila*)
Rust	(*Tranzschelia discolor* & *T. pruni spinosae*)

These diseases vary in occurrence and severity from year to year depending upon early season weather conditions. Almond production areas frequently experience from one to three rain periods during bloom and early fruit growth. New, ongoing research dealing with epidemiology of foliar diseases of almonds should be helpful in developing control strategies based on better timing of spray applications and reducing sprays when conditions for disease development are unfavorable.

Resistance to benomyl is prevalent in the *M. fructicola* and *M. laxa* populations in California and current recommendations dealing with fungicide applications recommend the use of fungicides of different chemistry as a companion or alternating product.

FUNGICIDE BENEFITS REPORT

COMMODITY: Almond Prunus amygdalus

GEOGRAPHIC PRODUCTION AREAS: Western States

1. **ACRES PLANTED:** 450,000

2. **ACRES HARVESTED:** 402,000

3. **ACRES TREATED:** 10 - 100%

4. **FUNGICIDE** Benomyl

   a. **Formulations:** 50W, 50DF

   b. **Federal/State recommendations or guidelines:**

Rate (ai/A)	No. of Applications	Timing range or avg.
.5 lb.	1 - 2	early, mid bloom

   c. **Methods of application:** Ground rig

   d. **Diseases subject to control:**

Common Name	Causal Organism	% Acres Infected	% Yield Loss Without Control
Brown rot	Monilinia fructicola, M. laxa	50	20
Blossom rot	Botrytis cinerea	10	3
Grn fruit rot	Botrytis cinerea Whetzelinia sclerotiorum	20	5

   e. **Normal (appropriate or typical) management practices using chemical and non-chemical control:** Application of fungicide during full bloom and clean cultivation; removal of mummies from tree reduces primary inoculum potential.

   f. **Alternative fungicides:** Thiophanate methyl, iprodione, triforine, maneb, captan

5. DISEASE MANAGEMENT STRATEGIES:

   a. **Resistance management:** High levels of resistance to benomyl. When benomyl used, must be used with captan.

b. **Management practices using <u>no</u> chemical pesticides:** Clean cultivation of orchards.

c. **Diseases <u>without</u> adequate controls:**

FUNGICIDE BENEFITS REPORT

COMMODITY Almond Prunus amygdalus

GEOGRAPHIC PRODUCTION AREAS Western States

1. **ACRES PLANTED:** 450,000

2. **ACRES HARVESTED:** 402,000

3. **ACRES TREATED:** 25%

4. **FUNGICIDE:** Captan

   a. **Formulations:** 50W

   b. **Federal/State recommendations or guidelines:**

Rate (ai/A)	No. of Applications	Timing range or avg.
4 lb.	1 - 4	early, mid, post bloom

   c. **Methods of application:** Ground rig

   d. **Diseases subject to control:**

Common Name	Causal Organism	% Acres Infected	% Yield Loss Without Control
Brown rot	M. fructicola, M. laxa	80	40
Shothole	Stigmina carpophila	80	unknown
Grn fruit rot	Botrytis cinerea	10-40	50 when rains occur
Leaf blight	Hendersonia rubi	5-25	unknown

   e. **Normal (appropriate or typical) management practices using chemical and non-chemical control:** For brown rot clean cultivation and removal of mummies. Fungicide sprays during bloom. For shothole furrow irrigation, one fungicide application at end of bloom.

   f. **Alternative fungicides:** Thiophanate methyl, benomyl, iprodione, ziram (shothole)

5. DISEASE MANAGEMENT STRATEGIES:

   a. **Resistance management:** Captan used in combination or alone to combat resistance to benomyl.

b. **Management practices using <u>no</u> chemical pesticides:** Brown rot clean cultivation.

c. **Diseases <u>without</u> adequate controls:**

FUNGICIDE BENEFITS REPORT

COMMODITY Almond Prunus amygdalus

GEOGRAPHIC PRODUCTION AREAS Western States

1. ACRES PLANTED: 450,000

2. ACRES HARVESTED: 402,000

3. ACRES TREATED: 42%

4. FUNGICIDE Copper

a. Formulations: Dust, wettable

b. Federal/State recommendations or guidelines:

Rate (ai/A)	No. of Applications	Timing range or avg.
8.0 lb	1 - 2	late spring, early summer

c. Methods of application: Ground rig

d. Diseases subject to control:

Common Name	Causal Organism	% Acres Infected	% Yield Loss Without Control
Rust	Tranzschelia discolor, T.	10	unknown
	Pruni-spinosae var. discolor	80	unknown
Shothole	Stigmina carpophyla		

e. Normal (appropriate or typical) management practices using chemical and non-chemical control: None

f. Alternative fungicides: None

5. DISEASE MANAGEMENT STRATEGIES:

a. Resistance management:

b. Management practices using no chemical pesticides: None

c. Diseases without adequate controls:

FUNGICIDE BENEFITS REPORT

COMMODITY Almond Prunus amygdalus

GEOGRAPHIC PRODUCTION AREAS Western States

1. ACRES PLANTED: 450,000

2. ACRES HARVESTED: 402,000

3. ACRES TREATED: 42%

4. FUNGICIDE Copper

a. Formulations: Flow, WP

b. Federal/State recommendations or guidelines:

Rate (ai/A)	No. of Applications	Timing range or avg.
4 lb	1 - 3	dormant, bloom

c. Methods of application: Ground rig

d. Diseases subject to control:

Common Name	Causal Organism	% Acres Infected	% Yield Loss Without Control
Frost		80	unknown

e. Normal (appropriate or typical) management practices using chemical and non-chemical control:

f. Alternative fungicides: None

5. DISEASE MANAGEMENT STRATEGIES:

a. Resistance management:

b. Management practices using no chemical pesticides:

c. Diseases without adequate controls:

FUNGICIDE BENEFITS REPORT

COMMODITY Almond Prunus amygdalus

GEOGRAPHIC PRODUCTION AREAS Western States

1. **ACRES PLANTED:** 450,000

2. **ACRES HARVESTED:** 402,000

3. **ACRES TREATED:** 50%

4. **FUNGICIDE** Iprodione

   a. **Formulations:** 50W

   b. **Federal/State recommendations or guidelines:**

Rate (ai/A)	No. of Applications	Timing range or avg.
.5 lb	1 - 3	early, mid, post bloom

   c. **Methods of application:** Air blast, ground rig

   d. **Diseases subject to control:**

Common Name	Causal Organism	% Acres Infected	% Yield Loss Without Control
Brown rot	Monilinia fructicola, M. laxa	80	40
Grn fruit rot	Botrytis cinerea	10	3

   e. **Normal (appropriate or typical) management practices using chemical and non-chemical control:** Clean cultivation, mummy removal and bloom sprays.

   f. **Alternative fungicides:** Benomyl, funginex, thiophanate methyl, captan

5. DISEASE MANAGEMENT STRATEGIES:

   a. **Resistance management:** None

   b. **Management practices using no chemical pesticides:** None

   c. **Diseases without adequate controls:**

FUNGICIDE BENEFITS REPORT

COMMODITY Almond *Prunus amygdalus*

GEOGRAPHIC PRODUCTION AREAS Western States

1. **ACRES PLANTED:** 450,000

2. **ACRES HARVESTED:** 402,000

3. **ACRES TREATED:** 12%

4. **FUNGICIDE** Thiophanate methyl

   a. **Formulations:** 50W

   b. **Federal/State recommendations or guidelines:**

Rate (ai/A)	No. of Applications	Timing range or avg.
.5 lb	1 - 2	Mid-late bloom

   c. **Methods of application:** Ground rig

   d. **Diseases subject to control:**

Common Name	Causal Organism	% Acres Infected	% Yield Loss Without Control
Brown rot	*M. fructicola* *M. laxa*	50	20

   e. **Normal (appropriate or typical) management practices using chemical and non-chemical control:** See previous page

   f. **Alternative fungicides:** Benomyl, iprodione, triforine, captan

5. DISEASE MANAGEMENT STRATEGIES:

   a. **Resistance management:**

   b. **Management practices using no chemical pesticides:** None

   c. **Diseases without adequate controls:**

FUNGICIDE BENEFITS REPORT

COMMODITY Almond Prunus amygdalus

GEOGRAPHIC PRODUCTION AREAS Western States

1. **ACRES PLANTED:** 450,000

2. **ACRES HARVESTED:** 402,000

3. **ACRES TREATED:** 5 - 10%

4. **FUNGICIDE** Triforine

   a. **Formulations:** EC, flowable

   b. **Federal/State recommendations or guidelines:**

Rate (ai/A)	No. of Applications	Timing range or avg.
1.2 lb	1 - 2	early, mid bloom

   c. **Methods of application:** Ground rig

   d. **Diseases subject to control:**

Common Name	Causal Organism	% Acres Infected	% Yield Loss Without Control
Brown rot	M. fructicola M. laxa	50	unknown

   e. **Normal (appropriate or typical) management practices using chemical and non-chemical control:** See previous pages

   f. **Alternative fungicides:** Benomyl, iprodione, thiophanate methyl, captan

5. DISEASE MANAGEMENT STRATEGIES:

   a. **Resistance management:** None

   b. **Management practices using no chemical pesticides:** None

   c. **Diseases without adequate controls:**

FUNGICIDE BENEFITS REPORT

COMMODITY Almond Prunus amygdalus

GEOGRAPHIC PRODUCTION AREAS Western States

1. ACRES PLANTED: 450,000

2. ACRES HARVESTED: 402,000

3. ACRES TREATED: 80%

4. FUNGICIDE Ziram

a. Formulations: 76W

b. Federal/State recommendations or guidelines:

Rate (ai/A)	No. of Applications	Timing range or avg.
5 - 7 lb.	1 - 4	Bloom - early leafing

c. Methods of application: Ground rig

d. Diseases subject to control:

Common Name	Causal Organism	% Acres Infected	% Yield Loss Without Control
Shothole	Stigmina carpophila	80	40

e. Normal (appropriate or typical) management practices using chemical and non-chemical control: 1 - 4 applications/year from bloom through early leafing.

f. Alternative fungicides: Captan, iprodione, maneb

5. DISEASE MANAGEMENT STRATEGIES:

a. Resistance management:

b. Management practices using no chemical pesticides: None

c. Diseases without adequate controls:

Fungicide Benefits on APPLE (*Malus domestica*)

Apple is a significant commercial crop grown in all regions of the United States on 468,010 acres with an annual production of 210 million bushels (8.82 billion pounds) and valued at $1.2 billion or 30% of the value of all noncitrus fruits (Table 1). More than 50 cultivars are grown, but the bulk of the production is limited to 8 to 10 with 'Delicious' accounting for approximately 1/3 of the production. Apple cultivars vary considerably in their susceptibility to approximately 20 fungal pathogens, 10 of which require fungicide usage for control in eastern apple growing regions.

Approximately 1/2 of the U. S. apple crop is produced in seven western states, 90% of which is produced in Washington and California (105,200 bu). Diseases of major concern in this region are post-harvest fruit rots and powdery mildew, caused by fungal pathogens, and fireblight caused by the bacterium (*Erwinia amylovora*). Thirty percent of the national production is in 11 northcentral and 7 northeastern states. In these regions, four or five diseases occur commonly, but apple scab (*Venturia inaequalis*) occurs in all orchards and can cause 90% loss if not controlled by fungicide sprays. Ten mid-Atlantic and southeastern states produce approximately 20% of the crop under environmental conditions highly favorable for 10 or more fungal diseases that can produce losses of from 60% to 90% if not controlled. Among the important fungal pathogens are five that produce fruit decay, four that produce fruit blemishes, three apple rusts, apple scab and powdery mildew. Fireblight, a bacterial pathogen, is more severe in this region because of higher rainfall and temperatures.

Control of the major diseases in commercial orchards is dependent upon the timely application of fungicides and bactericides usually applied as dilute or concentrate sprays with air delivery sprayers. The rate and number of applications varies with disease intensity and environmental conditions. In regions where apple scab is severe, control is maintained by applying protective fungicides such as captan, ferbam, mancozeb, thiram, and ziram used alone or in combination with dodine, benzimidazoles (benomyl, thiophanate methyl), or sterol-biosynthesis inhibitor (SBI) fungicides (fenarimol, myclobutanil). Captan or mancozeb are the protective fungicides most commonly used in combinations in managing fungicide tolerant pathogen populations or in preventing the development of tolerance in orchards. They are preferred because of their relatively high efficacy ratings even at concentrations reduced 40% to 50% of amounts registered for use alone. They also are the most efficacious against the pathogens causing fruit decay and limb cankers and in the mid-Atlantic and southeastern regions are used on 75% to 95% of the apple acreage treated. Integrated pest management tactics designed to minimize usage rates and number of applications are used in most apple orchards of the country. Post-infection control of apple scab is more feasible with the use of the SBI fungicides, but this method is limited by the need for thorough coverage of all plant parts, short residual life of these fungicides, and the risk of significant increases in fungicide usage if specific post-infection applications fail to provide complete control. Fireblight and Phytophthora collar/crown rot are two highly destructive diseases which often result in complete loss of trees and have very limited registered materials for their control. Effective chemicals for control of these diseases are at risk because of potential resistance development and

limited knowledge of biological control. Biological control methods for diseases affecting the above ground parts of apple trees is not presently feasible and little expectation for this approach is held for commercial orchards during the next decade.

The selection of alternative fungicides to replace those whose registration is in question is a complex matter because of the high diversity of the disease complex and the wide variation in mode of action and efficacy levels of many of the registered fungicides for apple. In addition to providing disease control, fungicides used on apples must be compatible with insecticides, acaricides, and bactericides which usually are tank mixed together to control other pests. Specifically, fungicides such as captan, diclon, dinocap, and sulfur are incompatible with spray oil used during the early season to improve control and prevent resistance development in mite populations. The relative efficacy levels against the more important diseases of apple is given in Table 2.

Table 1. Apple Bearing Acres and Production in the United States by Regions

State/Region	Bearing Acres - 1988	Production 42 lb bu (000) Mean 1984-1988
Northeast		
Connecticut	3,000	1,085
Maine	5,300	1,962
Massachusetts	7,400	2,267
New Hampshire	3,700	1,252
New York	61,000	22,857
Rhode Island	500	119
Vermont	4,500	1,086
Total	85,400	30,628
NorthCentral		
Arkansas	1,000	229
Illinois	1,300	207
Kansas	1,700	224
Kentucky	2,200	338
Michigan	53,500	21,190
Missouri	5,100	1,181
Minnesota	2,500	462
Ohio	8,700	2,928
Wisconsin	6,710	1,348
Total	94,910	31,812
Mid-Atlantic		
Delaware	1,000	547
Georgia	4,500	871
Maryland	4,600	1,624
New Jersey	6,000	2,191
North Carolina	11,500	7,119
Pennsylvania	27,000	13,143
South Carolina	4,500	829
Tennessee	1,700	288
Virginia	23,000	10,600
West Virginia	15,000	5,143
Total	98,800	42,355

Table 1 (continued)

West		
California	22,200	13,976
Colorado	5,000	1,824
Idaho	5,400	3,095
New Mexico	2,000	222
Oregon	9,000	3,667
Utah	3,300	1,162
Washington	142,000	81,238
Total	188,900	105,184
Total U.S.	468,010	209,979

Table 2. Efficacy of Fungicides Against Apple Diseases and Effect on Mites and Fruit Finish

	Degree of Disease Control[1]									
Fungicides	Scab	Powdery Mildew	Rusts	Black + White rot	Bitter rot	Blossom end rot (Botrytis)	Sooty blotch, Mite Fly speck	Suppression	Fruit finish[2]	Compatibility with spray oil
Benomyl[3]	1	2	5	3	5	2	1	3	3	yes
Captan	2	5	5	1	2	3	3	5	1	no
Dinocap	5	2	5	5	5	5	5	2	2	no
Dodine[3]	1	5	5	5	5	5	4	5	4	yes
Fenarimol	1	2	2	5	5	5	5	5	1	yes
Ferbam	3	5	2	2	4	4	2	5	4	yes
Mancozeb	2	5	2	1	1	2	1	4	1	yes
Metiram	2	5	2	1	1	2	1	4	1	yes
Myclobutanil	1	1	1	5	5	5	5	5	1	yes
Sulfur	4	3	4	4	4	4	4	4	4	no
Thiophanate methyl[3]	1	2	5	3	5	2	1	3	3	yes
Thiram	3	5	2	2	3	4	2	5	2	yes
Triadimefon	6	1	1	6	6	6	6	6	1	yes
Triforine	2	3	1	5	5	5	5	2	2	yes
Ziram	3	5	2	2	4	4	2	5	2	yes

[1] Degree of control under moderate to severe conditions: 1 = best, 2 = good, 3 = fair, 4 = slight, 5 = none, 6 = no registration
[2] Fruit finish on yellow cultivars: 1 = very good, 2 = good, 3 = fair, 4 = poor
[3] Tolerant strains of Venturia inaequalis (apple scab) have developed in many orchards

FUNGICIDE BENEFITS REPORT

COMMODITY Apple Malus domestica

GEOGRAPHIC PRODUCTION AREAS Western States

1. ACRES PLANTED: 155,726

2. ACRES HARVESTED: 117,895

3. ACRES TREATED: 10 -15%

4. FUNGICIDE benomyl

   a. Formulations: 50DF

   b. Federal/State recommendations or guidelines:

Rate (ai/A)	No. of Applications	Timing range or avg.
.75-1.5 lb.	1-2	post-harvest drench

   c. Methods of application: orchard sprayers, ground rig

   d. Diseases subject to control:

Common Name	Causal Organism	% Acres Infected	% Yield Loss Without Control
Powdery mildew	Podosphaeria leucotricha	50-60	5-20
Bull's eye rot	Pezicula malicorticis		
Grey mold	Botrytis cinerea	20-30	0-5
Scab	Venturia inaequalis	60-70	30-50 for fresh Mkt

   e. Normal (appropriate or typical) management practices using chemical and non-chemical control: Scab - predict disease using forecasting machines, fungicides used after infection periods.

   f. Alternative fungicides: Sulfur, Bayleton, Ralley, Rubigan

5. DISEASE MANAGEMENT STRATEGIES:

   a. Resistance management: Benlate is recommended only as an alternative due to the existence or possibility of resistance.

   b. Management practices using no chemical pesticides: None

   c. Diseases without adequate controls: None

FUNGICIDE BENEFITS REPORT

COMMODITY Apple *Malus domestica*

GEOGRAPHIC PRODUCTION AREAS Western States

1. **ACRES PLANTED:** 155,726

2. **ACRES HARVESTED:** 117,895

3. **ACRES TREATED:** 7%

4. **FUNGICIDE** captan

   a. **Formulations:** 50W

   b. **Federal/State recommendations or guidelines:**

Rate (ai/A)	No. of Applications	Timing range or avg.
2.0-4.0 lb.	1-2	green tip-2nd cover spray

   c. **Methods of application:** ground rig

   d. **Diseases subject to control:**

Common Name	Causal Organism	% Acres Infected	% Yield Loss Without Control
Bull's eye rot	*Pezicula malicorticis*		
Powdery mildew	*Podosphaeria leucotricha*	5-30	5-20
Scab	*Venturia inaequalis*	100	60-70

   e. **Normal (appropriate or typical) management practices using chemical and non-chemical control:** Early season fungicide sprays for powdery mildew. Scab sprays generally are based on disease forecasting.

   f. **Alternative fungicides:** benomyl, dodine, fenarimol, ferbam, triforine, lime sulfur, mancozeb, wettable sulfur, ziram

5. DISEASE MANAGEMENT STRATEGIES:

   a. **Resistance management:** Resistance to benomyl in the *V. inaequalis* population requires use of captan in tank mix.

   b. **Management practices using no chemical pesticides:** None

   c. **Diseases without adequate controls:**

FUNGICIDE BENEFITS REPORT

COMMODITY Apple Malus domestica

GEOGRAPHIC PRODUCTION AREAS Western States

1. ACRES PLANTED: 155,726

2. ACRES HARVESTED: 117,895

3. ACRES TREATED: 90-100%

4. FUNGICIDE Mancozeb

a. Formulations: Dikar 45 WP

b. Federal/State recommendations or guidelines:

Rate (ai/A)	No. of Applications	Timing range or avg.
2-4 lb	2-5	pre-pink, to first cover/ greentip - 2nd cover

c. Methods of application: Ground rig

d. Diseases subject to control:

Common Name	Causal Organism	% Acres Infected	% Yield Loss Without Control
Scab	Venturia inaequalis	5-100	20-30

e. Normal (appropriate or typical) management practices using chemical and non-chemical control: Chemical control. Post infection programs with EBI fungicides, reduce duration of overtree sprinkling.

f. Alternative fungicides: dodine, fenarimol, myclobutanil/captan, ferbam, sulfur, ziram, benomyl/ fenarimol

5. DISEASE MANAGEMENT STRATEGIES:

a. Resistance management: None

b. Management practices using no chemical pesticides: sanitation

c. Diseases without adequate controls: fire blight, fruit russeting

FUNGICIDE BENEFITS REPORT

COMMODITY Apple Malus domestica

GEOGRAPHIC PRODUCTION AREAS Western States

1. **ACRES PLANTED:** 155,726

2. **ACRES HARVESTED:** 117,895

3. **ACRES TREATED:** 90-100%

4. **FUNGICIDE** Sulfur

   a. **Formulations:** WP

   b. **Federal/State recommendations or guidelines:**

Rate (ai/A)	No. of Applications	Timing range or avg.
2-5 lbs	2-3	pink, every two weeks

   c. **Methods of application:** blower

   d. **Diseases subject to control:**

Common Name	Causal Organism	% Acres Infected	% Yield Loss Without Control
Powdery mildew	Podosphaeria leucotricha	50	10

   e. **Normal (appropriate or typical) management practices using chemical and non-chemical control:** Begin sprays at pink and every two weeks. Resistant varieties and fungicide sprays.

   f. **Alternative fungicides:** Bayleton, benomyl

5. DISEASE MANAGEMENT STRATEGIES:

   a. **Resistance management:** None

   b. **Management practices using no chemical pesticides:** resistant varieties

   c. **Diseases without adequate controls:** Southern blight

FUNGICIDE BENEFITS REPORT

COMMODITY Apple Malus domestica

GEOGRAPHIC PRODUCTION AREAS Western States

1. ACRES PLANTED: 155,726

2. ACRES HARVESTED: 117,895

3. ACRES TREATED: 50%

4. FUNGICIDE Triadimefon

   a. Formulations: 50W, 50DF

   b. Federal/State recommendations or guidelines:

Rate (ai/A)	No. of Applications	Timing range or avg.
1-4 oz	2-3	pink, every two weeks

   c. Methods of application: Ground rig

   d. Diseases subject to control:

Common Name	Causal Organism	% Acres Infected	% Yield Loss Without Control
Powdery mildew	Podosphaeria leucotricha	50%	10-20

   e. Normal (appropriate or typical) management practices using chemical and non-chemical control: Resistant varieties, fungicide sprays.

   f. Alternative fungicides: benomyl, sulfur

5. DISEASE MANAGEMENT STRATEGIES:

   a. Resistance management: None

   b. Management practices using no chemical pesticides: Resistant varieties

   c. Diseases without adequate controls:

Fungicide Benefits on Apricot (*Prunus armeniaca*)

Apricots are grown commercially in the western states of California (approximately 21,500 acres), Washington (600 acres) and Utah (100 acres). Total production in 1988 was 102,300 tons. Of the total production, approximately 53% is used for processing, 12 % for fresh market, 22 % is dried and 10% was frozen. Diseases of fruit, foliage and wood account for 25-100% loss when fungicides are not used. Severe losses occur in the form of fruit rots caused by *M. laxa* and *M. fructicola* during spring when rains occur or if rains occur prior to harvest. Cytospora canker (*Eutypa lata*) results from infection of pruning wounds and may result in significant scaffold branch loss if wounds are left unprotected. Shothole (*Stigmina carpophila*) accounts for significant losses in some years. Infections of the upper fruit surface result in blemishes which reduce grade for all uses.

Production of apricots requires protective fungicide sprays during bloom in most years to prevent brown rot blossom blight and fruit rot. In addition sprays, for *Stigmina carpophila* are made in late fall and pre-bloom.

Table 3. Apricots Bearing Acres and Production in the United States by Regions.

State/Region	Bearing Acres-1988	Production Tons-1988
West		
California	21,500	95,000
Utah	100	1,200
Washington	600	6,100
Total	22,200	102,300
Total U.S.	22,200	102,300

FUNGICIDE BENEFITS REPORT

COMMODITY Apricot Prunus armeniaca

GEOGRAPHIC PRODUCTION AREAS Western States

1. **ACRES PLANTED:** 29,748

2. **ACRES HARVESTED:** 28,000

3. **ACRES TREATED:** 10%

4. **FUNGICIDE** Benomyl

   a. **Formulations:** Benlate 150W, 50DF

   b. **Federal/State recommendations or guidelines:**

Rate (ai/A)	No. of Applications	Timing range or avg.
.001-1.5 lb	1	red bud

   c. **Methods of application:** Ground rig, air blast

   d. **Diseases subject to control:**

Common Name	Causal Organism	% Acres Infected	% Yield Loss Without Control
Brown rot	M. fructicola, M. laxa	100	90
Cytospora Canker	Eutypa lata	50	2.5

   e. **Normal (appropriate or typical) management practices using chemical and non-chemical control:** Clean cultivation and removal of mummies in addition to fungicide application for Brown rot control for Cytospora canker, removal of affected branches and fungicide.

   f. **Alternative fungicides:** Thiabendazole

5. DISEASE MANAGEMENT STRATEGIES:

   a. **Resistance management:** Monilinia spp. resistant to benomyl. Captan used as companion product.

   b. **Management practices using no chemical pesticides:** Clean cultivation, pruning of diseased branches.

   c. **Diseases without adequate controls:**

FUNGICIDE BENEFITS REPORT

COMMODITY Apricot Prunus armeniaca

GEOGRAPHIC PRODUCTION AREAS Western States

1. ACRES PLANTED: 29,748

2. ACRES HARVESTED: 28,000

3. ACRES TREATED: 80%

4. FUNGICIDE Captan

a. Formulations: Captan 50W

b. Federal/State recommendations or guidelines:

Rate (ai/A)	No. of Applications	Timing range or avg.
12.0 lb 2.3 lb	3-4	pre-bloom, bloom summer shuck, split fall

c. Methods of application: Ground rig, air blast

d. Diseases subject to control:

Common Name	Causal Organism	% Acres Infected	% Yield Loss Without Control
Brown rot	M. fructicola, M. laxa	60	100
Shothole	Stigmina carpophila	100	50

e. Normal (appropriate or typical) management practices using chemical and non-chemical control: Chemical control

f. Alternative fungicides: Copper, chlorothalonil, benomyl, iprodione

5. DISEASE MANAGEMENT STRATEGIES:

a. Resistance management:

b. Management practices using no chemical pesticides: Cultural practices appropriate for each disease

c. Diseases without adequate controls: Cytospora canker

FUNGICIDE BENEFITS REPORT

COMMODITY Apricot *Prunus armeniaca*

GEOGRAPHIC PRODUCTION AREAS Western States

1. **ACRES PLANTED:** 29,748

2. **ACRES HARVESTED:** 28,000

3. **ACRES TREATED:** 9-25%

4. **FUNGICIDE** Chlorothalonil

   a. **Formulations:** 50W

   b. **Federal/State recommendations or guidelines:**

Rate (ai/A)	No. of Applications	Timing range or avg.
3.13 lb	1	pre-bloom, late shuck split

   c. **Methods of application:** Ground rig, air blast

   d. **Diseases subject to control:**

Common Name	Casual Organism	% Acres Infected	% Yield Loss Without Control
Shothole	*Stigmina carpophila*	100	50

   e. **Normal (appropriate or typical) management practices using chemical and non-chemical control:** Chemical control at late shuck split or pre-bloom

   f. **Alternative fungicides:** Copper, captan, iprodione

5. DISEASE MANAGEMENT STRATEGIES:

   a. **Resistance management:**

   b. **Management practices using no chemical pesticides:** Cultural practices appropriate for each disease

   c. **Diseases without adequate controls:** Cytospora canker

FUNGICIDE BENEFITS REPORT

COMMODITY Apricot Prunus armeniaca

GEOGRAPHIC PRODUCTION AREAS Western States

1. ACRES PLANTED: 29,748

2. ACRES HARVESTED: 28,000

3. ACRES TREATED: 50%

4. FUNGICIDE Triadimefon

a. Formulations:

b. Federal/State recommendations or guidelines:

Rate (ai/A)	No. of Applications	Timing range or avg.
1-4 oz	2-3	pink, every two weeks

c. Methods of application: Ground rig, air blast

d. Diseases subject to control:

Common Name	Causal Organism	% Acres Infected	% Yield Loss Without Control
Powdery mildew	Podosphaeria leucotricha	50	10-20

e. Normal (appropriate or typical) management practices using chemical and non-chemical control: resistant varieties, fungicide sprays

f. Alternative fungicides: benomyl, sulfur

5. DISEASE MANAGEMENT STRATEGIES:

a. Resistance management: none

b. Management practices using no chemical pesticides: resistant varieties

c. Diseases without adequate controls:

FUNGICIDE BENEFITS REPORT

COMMODITY Apricot Prunus armeniaca

GEOGRAPHIC PRODUCTION AREAS Western States

1. ACRES PLANTED: 29,748

2. ACRES HARVESTED: 28,000

3. ACRES TREATED: 25%

4. FUNGICIDE Ziram

   a. Formulations: 80W

   b. Federal/State recommendations or guidelines:

Rate (ai/A)	No. of Applications	Timing range or avg.
2 lbs	1	shuck split

   c. Methods of application: Ground rig, air blast

   d. Diseases subject to control:

Common Name	Causal Organism	% Acres Infected	% Yield Loss Without Control
Shothole	Stigmina carpophila	100	50

   e. Normal (appropriate or typical) management practices using chemical and non-chemical control: fungicide applications at late shuck split

   f. Alternative fungicides: chlorothalonil

5. DISEASE MANAGEMENT STRATEGIES:

   a. Resistance management:

   b. Management practices using no chemical pesticides: none

   c. Diseases without adequate controls:

Fungicide Benefits on Banana (*Musa paradisiaca*)

Banana production in the Western U.S. is confined to Hawaii. There currently are 1220 bearing acres on the islands. Black leaf streak, caused by *Mycosphaerella* sp., requires 12-15 applications of mancozeb for control. One hundred percent of the acreage is affected, and no alternative fungicide exists. Yield loss without control is approximately 30 percent.

FUNGICIDE BENEFITS REPORT

COMMODITY Banana Musa paradisiaca

GEOGRAPHIC PRODUCTION AREAS Western States

1. **ACRES PLANTED:** 1220

2. **ACRES HARVESTED:** 1220

3. **ACRES TREATED:** 100%

4. **FUNGICIDE** Mancozeb

   a. **Formulations:** FL

   b. **Federal/State recommendations or guidelines:**

Rate (ai/A)	No. of Applications	Timing range or avg.
3 lbs.	12-15	7-14 day intervals

   c. **Methods of application:** Ground rig

   d. **Diseases subject to control:**

Common Name	Causal Organism	% Acres Infected	% Yield Loss Without Control
Black leaf streak	Mycosphaerella sp.	100	30

   e. **Normal (appropriate or typical) management practices using chemical and non-chemical control:** Usually applied in summer. Do not apply in dry months, but may be applied at two to four week intervals when disease pressure is high.

   f. **Alternative fungicides:** None

5. DISEASE MANAGEMENT STRATEGIES:

   a. **Resistance management:**

   b. **Management practices using no chemical pesticides:** None

   c. **Diseases without adequate controls:** Mycosphaerella

Fungicide Benefits on BLUEBERRY (Vaccinium corymbosum or V. ashei)

Blueberries grown commercially are primarily of two types; high bush (Vaccinium corymbosum) and rabbit's eye (V. ashei). Recorded acreage of these types grown in 14 states amount to 30,250 acres, 92% of which are grown in Michigan (18,000 acres), Massachusetts (2,000 acres), and New Jersey (7,800 acres) (Table 4). The southeastern states of North Carolina (3,600 acres) and Georgia (3,000 acres) grow 22% of the acreage. Less than 5% of the commercial blueberry acreage is grown in the western states of Washington (800 acres) and Oregon (600 acres). It is likely that several thousand additional acres are grown in small plantings that are not recorded but are produced as a commercial crop. The lowbush blueberry (V. angustifolium) commonly found growing wild along the Appalachian mountain chain from Alabama to Maine is managed for harvesting in some areas. An estimated 17,300 acres in Maine are managed for commercial consumption, but are generally not sprayed for pest control. The highbush and rabbit eye crops yield about 140 million pounds valued at approximately $100 million annually. The lowbush crop has been estimated at 80 million pounds bringing the estimated total value to $157 million.

Five or more fungal diseases that require fungicides for control occur widely and affect 30% to 90% of the commercial acreage. Yield losses due to leaf and twig blights, fruit rot, stem canker, and root rot ranges from 25% to 60% if not controlled. Disease losses are kept to commercially acceptable levels through the use of resistant cultivars, pruning, removal of diseased plant parts, and seasonally applied fungicide sprays. Protective fungicides benomyl, captan, or the combination of both are used on 50% to 75% of the acreage from budbreak through bloom. Triforine is also used on as much as 65% of the acreage during the same early season period under highly favorable environmental conditions for infection on leaves, stems, and fruit. Essentially all commercial plantings require 2 to 4 fungicide applications annually.

Table 4. Blueberry Bearing Acreage in the United States by Regions.

State/Region	Bearing Acres-1988	
	Highbush	Lowbush
Northeast		
Maine	50	17,300
Massachusetts	2,000	
New York	850	
Rhode Island	300	
Total	3,200	17,300
Northcentral		
Michigan	18,000	
Missouri	225	
Ohio	350	
Total	18,575	--
Southeast		
Georgia	3,000	
North Carolina	3,600	
South Carolina	400	
Tennessee	75	
Total	7,075	--
West		
Oregon	600	
Washington	800	
Total	1,400	
Total U. S.	30,250	17,300

FUNGICIDE BENEFITS REPORT

COMMODITY Blueberry Vaccinium corymbosum

GEOGRAPHIC PRODUCTION AREAS Western States

1. ACRES PLANTED: 2150

2. ACRES HARVESTED: 2150

3. ACRES TREATED: 11-33%

4. FUNGICIDE Benomyl

a. Formulations: WP & DF Flowable

b. Federal/State recommendations or guidelines:

Rate (ai/A)	No. of Applications	Timing range or avg.
.375-.5 lb	1	bloom

c. Methods of application: hydraulic, Ground rig

d. Diseases subject to control:

Common Name	Causal Organism	% Acres Infected	% Yield Loss Without Control
Anthracnose	Gloeosporium gloeasporioides	5	30
Blossom blight	Botrytis cinerea	95	95
Mummy berry	Monilinia vaccinii-corymbosi	35	50

e. Normal (appropriate or typical) management practices using chemical and non-chemical control: in spring, follow up to 3 applications (pre-bloom) of triforine, then 2 applications of Benlate and captan during bloom. Do not use benomyl exclusively.

f. Alternative fungicides: triforine (mummy berry only), captan

5. DISEASE MANAGEMENT STRATEGIES:

a. Resistance management: benomyl not used exclusively.

b. Management practices using no chemical pesticides: use urea fertilizer for mummy berry

c. Diseases without adequate controls: botrytis blossom blight, cultural control of mummy berry is not possible by itself. Anthracnose

FUNGICIDE BENEFITS REPORT

COMMODITY Blueberry Vaccinium corymbosum

GEOGRAPHIC PRODUCTION AREAS Western States

1. **ACRES PLANTED:** 2150

2. **ACRES HARVESTED:** 2150

3. **ACRES TREATED:** 27-95%

4. **FUNGICIDE** Captan

   a. **Formulations:** WP, DF, Flowable

   b. **Federal/State recommendations or guidelines:**

Rate (ai/A)	No. of Applications	Timing range or avg.
.3-2.0 lb	1-2	bloom

   c. **Methods of application:** hydraulic, ground rig, air blast

   d. **Diseases subject to control:**

Common Name	Causal Organism	% Acres Infected	% Yield Loss Without Control
Anthracnose	Colletotrichum gloeosporioides	5	30
Blossom blight	Botrytis cinerea	100	40
Mummy berry	Monilinia vaccinii	35	50

   e. **Normal (appropriate or typical) management practices using chemical and non-chemical control:** mummy berry - in early spring, cultivate to disrupt germination. Three applications of triforine followed by 1-2 applications of benomyl + captan during bloom. For blossom blight-bloom, sprays of benomyl & captan.

   f. **Alternative fungicides:** triforine (mummy berry only), benomyl

5. DISEASE MANAGEMENT STRATEGIES:

   a. **Resistance management:** use of fungicides with different chemistry

   b. **Management practices using no chemical pesticides:** None for blossom blight. Mummy berry - spring cultivation use urea fertilizer

   c. **Diseases without adequate controls:** Anthracnose, Godonia (Fusicoccum) canker

Fungicide Benefits on CANEBERRIES

Red Raspberry (Rubus ideaus strigosus)
Black Raspberry (Rubus occidentalis)
Loganberry (Boysenberry) (Rubus loganobaccus)
Dewberry (Rubus flagellaris)
Blackberry (Rubus allegheniensis)

Caneberries are grown throughout the United States in relatively small plantings many of which are not reported as commercial acreage. Estimates of acreages produce for commercial sales ranges from 10,000 to 20,000 acres. Most states report less than 1,000 acres with about equal acreage in the northeast (6 states), northcentral (4 states), and western regions. Raspberries are grown most commonly as a commercial crop (11,500 acres) while blackberries are grown commercially (7,650 acres) and also harvested from many wild plantings along fence rows and in uncultivated fields. The estimated crop of 96 million pounds is valued between $72 - $120 million.

Five to seven fungal diseases are commonly found on caneberry crops grown in humid regions. Anthracnose and fruit rot occurs on 60% to 70% of the acreage with losses of up to 100% where not controlled. Leaf and cane spot, spur blight, and powdery mildew occur on susceptible types or cultivars and may cause damage ranging from 15% to 80%. Fungicidal sprays are generally required for acceptable control. No registered fungicide is effective against orange rust and knowledge of efficacy of the relatively new fungicides is limited. The selection and planting of resistant cultivars, annual pruning, removal of diseased parts, and trellising are helpful in preventing excessive loss due to fungal diseases.

Table 5. Caneberry Bearing Acres and Production in the United States by Regions.

State/Region	Bearing Acres-1988
Northeast	
Maine	100
Massachusetts	1,000
New Jersey	300
New York	500
Pennsylvania	400
Rhode Island	75
Total	2,375
Northcentral	
Illinois	100
Michigan	1,000
Missouri	75
Ohio	1500
Total	2,675
Southeast	
Georgia	40
North Carolina	400
South Carolina	375
Tennessee	90
Total	905
West	
California	3,500
Oregon	10,790
Washington	3,500
Total	17,790
Total U.S.	23,745

FUNGICIDE BENEFITS REPORT

COMMODITY Blackberry Rubus allegheniensis

GEOGRAPHIC PRODUCTION AREAS Western States

1. ACRES PLANTED: 6030

2. ACRES HARVESTED: 6030

3. ACRES TREATED: 50-80%

4. FUNGICIDE Benomyl

a. Formulations: 50W, WP, DF

b. Federal/State recommendations or guidelines:

Rate (ai/A)	No. of Applications	Timing range or avg.
.375-.5 lb	1	blossom & up to harvest

c. Methods of application: Ground rig

d. Diseases subject to control:

Common Name	Causal Organism	% Acres Infected	% Yield Loss Without Control
Fruit rot	Botrytis cinerea	100	25
Powdery mildew	Sphaerotheca macularis	10	15

e. Normal (appropriate or typical) management practices using chemical and non-chemical control: do not use benomyl excessively - treat less than 1% of acreage DCNA

f. Alternative fungicides: captan, iprodione
powdery mildew: sulfur, dinocap

5. DISEASE MANAGEMENT STRATEGIES:

a. Resistance management: Alternate or tank mix with fungicides of different chemistry.

b. Management practices using no chemical pesticides: proper trellising. Overhead irrigation during harvest, frequent picking.

c. Diseases without adequate controls:

FUNGICIDE BENEFITS REPORT

COMMODITY Blackberry Rubus allegheniensis

GEOGRAPHIC PRODUCTION AREAS Western States

1. ACRES PLANTED: 6030

2. ACRES HARVESTED: 6030

3. ACRES TREATED: 50%

4. FUNGICIDE Captan

a. Formulations: WP

b. Federal/State recommendations or guidelines:

Rate (ai/A)	No. of Applications	Timing range or avg.
.375-.5 lb	1	blossom & up to harvest

c. Methods of application: Ground rig

d. Diseases subject to control:

Common Name	Causal Organism	% Acres Infected	% Yield Loss Without Control
Fruit rot	Botrytis cinerea	100	25

e. Normal (appropriate or typical) management practices using chemical and non-chemical control:

f. Alternative fungicides: Rovral, except CA

5. DISEASE MANAGEMENT STRATEGIES:

a. Resistance management: no resistance to Captan known

b. Management practices using no chemical pesticides: wide row spacing, trellising, do not over-fertilize, weed control, frequent picking.

c. Diseases without adequate controls:

FUNGICIDE BENEFITS REPORT

COMMODITY Boysenberry, Loganberry, Tayberry Rubus loganobaccus

GEOGRAPHIC PRODUCTION AREAS Western States

1. ACRES PLANTED: 1790

2. ACRES HARVESTED: 1790

3. ACRES TREATED: 50%

4. FUNGICIDE Benomyl

   a. Formulations: 50WP, 50DF

   b. Federal/State recommendations or guidelines:

Rate (ai/A)	No. of Applications	Timing range or avg.
.375-.5 lb.	1	Bloom & up to harvest

   c. Methods of application: Ground rig

   d. Diseases subject to control:

Common Name	Causal Organism	% Acres Infected	% Yield Loss Without Control
Fruit rot	Botrytis cinerea	100	25

   e. Normal (appropriate or typical) management practices using chemical and non-chemical control: Generally crop is sprayed only at the threat of rain.

   f. Alternative fungicides: Rovral, captan

5. DISEASE MANAGEMENT STRATEGIES:

   a. Resistance management: Resistance to benomyl known in Botrytis population - limit number of applications; alternate products of differing chemistry

   b. Management practices using no chemical pesticides: Wide row spacing, trellising, weed control, no overhead irrigation, not over fertilized, new cane management

   c. Diseases without adequate controls:

COMMODITY Boysenberry, Loganberry, Tayberry Rubus loganobaccus

GEOGRAPHIC PRODUCTION AREAS Western States

1. **ACRES PLANTED:** 1790

2. **ACRES HARVESTED:** 1790

3. **ACRES TREATED:** 40%

4. **FUNGICIDE** Captan

   a. **Formulations:** 50WP, 50DF

   b. **Federal/State recommendations or guidelines:**

Rate (ai/A)	No. of Applications	Timing range or avg.
1 - 2 lb.	1	bloom & up to harvest

   c. **Methods of application:** Ground rig

   d. **Diseases subject to control:**

Common Name	Causal Organism	% Acres Infected	% Yield Loss Without Control
Fruit rot	Botrytis cinerea	100	25

   e. **Normal (appropriate or typical) management practices using chemical and non-chemical control:** Cultural practices and fungicides.

   f. **Alternative fungicides:** Benomyl, metalaxyl

5. DISEASE MANAGEMENT STRATEGIES

   a. **Resistance management:** None

   b. **Management practices using no chemical pesticides:** Row spraying, trellising, weed control, cane management, not using overhead irrigation

   c. **Diseases without adequate controls:**

FUNGICIDE BENEFITS REPORT

COMMODITY Boysenberry, Loganberry, Tayberry Rubus loganobaccus

GEOGRAPHIC PRODUCTION AREAS Western States

1. **ACRES PLANTED:** 1790

2. **ACRES HARVESTED:** 1790

3. **ACRES TREATED:** 83%

4. **FUNGICIDE** Metalaxyl

   a. **Formulations:** 2E

   b. **Federal/State recommendations or guidelines:**

Rate (ai/A)	No. of Applications	Timing range or avg.
1 pt/1000 ft row	2	Oct. and March

   c. **Methods of application:** Ground rig - over vine

   d. **Diseases subject to control:**

Common Name	Causal Organism	% Acres Infected	% Yield Loss Without Control
Downy Mildew	Peronospora sparsa	90	50 - 90

   e. **Normal (appropriate or typical) management practices using chemical and non-chemical control:** Fungicide application in Fall and Spring.

   f. **Alternative fungicides:** None

5. DISEASE MANAGEMENT STRATEGIES:

   a. **Resistance management:** Tank mix with copper and limit application number to 2 per year

   b. **Management practices using no chemical pesticides:** Use disease free planting material

   c. **Diseases without adequate controls:** None

FUNGICIDE BENEFITS REPORT

COMMODITY Red Raspberries Rubus ideaus strigosus

GEOGRAPHIC PRODUCTION AREAS Western States

1. ACRES PLANTED: 8,140

2. ACRES HARVESTED: 8,140

3. ACRES TREATED: 75%

4. FUNGICIDE benomyl

a. Formulations: WP, DF

b. Federal/State recommendations or guidelines:

Rate (ai/A)	No. of Applications	Timing range or avg.
.500 lb	2-3	spring, early bloom to harvest

c. Methods of application: Ground rig

d. Diseases subject to control:

Common Name	Causal Organism	% Acres Infected	% Yield Loss Without Control
Cane blight	Leptosphaeria coniothyrium	59	4
Fruit rot	Botrytis cinerea, Rhizopus, Cladosporium, Alternaria	100	35

e. Normal (appropriate or typical) management practices using chemical and non-chemical control:

f. Alternative fungicides: vinclozolin, iprodione

5. DISEASE MANAGEMENT STRATEGIES:

a. Resistance management: None

b. Management practices using no chemical pesticides: Frequent picking, remove old fruiting canes immediately after harvest, use trickle or drip irrigation, do not over-fertilize, training system.

c. Diseases without adequate controls: Cane blight

FUNGICIDE BENEFITS REPORT

COMMODITY Red Raspberries Rubus ideaus strigosus

GEOGRAPHIC PRODUCTION AREAS Western States

1. ACRES PLANTED: 8,140

2. ACRES HARVESTED: 8,140

3. ACRES TREATED: 75%

4. FUNGICIDE captan

a. Formulations: WP, F

b. Federal/State recommendations or guidelines:

Rate (ai/A)	No. of Applications	Timing range or avg.
1-2 lbs	2-3	early bloom harvest, post harvest

c. Methods of application: hydraulic airblast

d. Diseases subject to control:

Common Name	Causal Organism	% Acres Infected	% Yield Loss Without Control
Grey mold, fruit rot	Botrytis cinerea	100	10
Fruit rot	Rhizopus, Alternaria, Cladosporium	50	5

e. Normal (appropriate or typical) management practices using chemical and non-chemical control:

f. Alternative fungicides: benomyl, vinclozolin, iprodione

5. DISEASE MANAGEMENT STRATEGIES:

a. Resistance management: None

b. Management practices using no chemical pesticides: Frequent picking, remove old fruiting canes immediately after harvest. Do not over-fertilize or use overhead irrigation.

c. Diseases without adequate controls: Cane blight

FUNGICIDE BENEFITS REPORT

COMMODITY Black Raspberries Rubus occidentalis

GEOGRAPHIC PRODUCTION AREAS Western States

1. ACRES PLANTED: 1,600

2. ACRES HARVESTED: 1,600

3. ACRES TREATED: 50%

4. FUNGICIDE Benomyl

a. Formulations: WP, DF

b. Federal/State recommendations or guidelines:

Rate (ai/A)	No. of Applications	Timing range or avg.
.375-.5 lbs	1	bloom-harvest

c. Methods of application: Ground rig

d. Diseases subject to control:

Common Name	Causal Organism	% Acres Infected	% Yield Loss Without Control
Fruit rot	Botrytis cinerea	100	10
Cane blight	Leptosphaeria coniothyrium		

e. Normal (appropriate or typical) management practices using chemical and non-chemical control: use of fungicides, pruning

f. Alternative fungicides: captan, iprodione

5. DISEASE MANAGEMENT STRATEGIES:

a. Resistance management: None

b. Management practices using no chemical pesticides: Weed control, pruning, row spacing, do not use overhead irrigation. Cane blight is only a problem in fields that are harvested by machine & then in the season following a rainy harvest. The pathogen affects wounds on the canes made by the harvester. Benomyl is the only fungicide that will control cane blight.

c. Diseases without adequate controls:

FUNGICIDE BENEFITS REPORT

COMMODITY Black Raspberries Rubus occidentalis

GEOGRAPHIC PRODUCTION AREAS Western States

1. ACRES PLANTED: 1,600

2. ACRES HARVESTED: 1,600

3. ACRES TREATED: 50%

4. FUNGICIDE Captan

a. Formulations: WP, F

b. Federal/State recommendations or guidelines:

Rate (ai/A)	No. of Applications	Timing range or avg.
1-2 lbs	1	bloom to beginning of harvest

c. Methods of application: Ground rig

d. Diseases subject to control:

Common Name	Causal Organism	% Acres Infected	% Yield Loss Without Control
Fruit rot	Botrytis cinerea	100	10

e. Normal (appropriate or typical) management practices using chemical and non-chemical control:

f. Alternative fungicides: benomyl, iprodione

5. DISEASE MANAGEMENT STRATEGIES:

a. Resistance management: None

b. Management practices using no chemical pesticides: Frequent picking, wide row spacing, no overhead irrigation, pruning, weed control, not overfertilizing.

c. Diseases without adequate controls:

Fungicide Benefits on CHERRY
Tart (Prunus syringae)
Sweet (Prunus avium)

The commercial production of tart and sweet cherries in the United States is 304,300 metric tons annually valued at $200 million. Although the acreage of each are similar nationally (tart, 47,810 acres; sweet, 47,100 acres), the major acreage of tarts is in Michigan, New York, Utah, Oregon, and Pennsylvania, while the major sweet cherry production is in Washington, Oregon, California, and Michigan (Table 6). The sweet cherry crop is valued at $145.4 million and tarts have an annual value of $53.9 million.

Both tart and sweet cherries are susceptible to five or more fungal pathogens that require fungicide sprays for control. Sweet cherries or more susceptible to brown rot on blossoms and fruit. Brown rot occurs on 75% to 100% of the acreage and causes from 60% to 100% loss if not treated with fungicides. Cherry leaf spot affects both sweet and tart cherries, but losses are greater on tarts. This fungus disease occurs in essentially all orchards and may cause 80% to 100% yield loss due to defoliation. The prevention of premature defoliation is very important because it can lead to low temperature injury which can cause death of trees in the colder climates of the northcentral and northeastern regions. Effective fungicides must be applied to prevent tree losses.

Strains of the fungi causing brown rot and leaf spot that are resistant to dodine and benzimidazole fungicides have developed in orchards extensively sprayed with these fungicides. Other effective fungicides such as captan, chlorothalonil, triforine, iprodione, and vinclozolin must be used in these orchards at significantly higher rates and costs. Strains of the brown rot pathogen resistant to iprodione and vinclozolin have also been reported in some commercial orchards. Captan and chlorothalonil are companion fungicides that are used in combination to delay the development of resistance.

Table 6. Cherry Bearing Acres and Production in the United States by Regions

State/Region	Bearing Acres-1988 Tart	Bearing Acres-1988 Sweet	Production Tons Tart	Production Tons Sweet
Northeast				
New York	5,200	700	11,000	1,400
Total	5,200	700	11,000	1,400
Northcentral				
Michigan	33,300	9,400	90,000	28,000
Wisconsin	2,810	--	4,450	--
Total	36,110	9,400	94,450	28,000
Mid-Atlantic				
Pennsylvania	1,600	300	4,500	1,200
Total	1,600	300	4,500	1,200
West				
California		10,300		26,000
Colorado	400	--	650	--
Idaho	--	600	--	2,300
Montana	--	900	--	3,300
Oregon	1,800	11,300	2,000	60,000
Utah	2,700	800	5,500	2,000
Washington	--	12,800	--	62,000
Total	4,900	36,700	8,150	155,600
Total U.S.	47,810	47,100	118,100	186,200

COMMODITY Sweet Cherries *Prunus avium*
Tart Cherries *Prunus syringae*

GEOGRAPHIC PRODUCTION AREAS Western States

1. **ACRES PLANTED:** 37,126

2. **ACRES HARVESTED:** 37,126

3. **ACRES TREATED:** 7 - 90%

4. **FUNGICIDE** Benomyl

   a. **Formulations:** 50W, 50DF

   b. **Federal/State recommendations or guidelines:**

Rate (ai/A)	No. of Applications	Timing range or avg.
4 oz/100 gal	1	post-harvest
.75 - 1 lb	1	bloom
.001 lb		
4 oz/100 gal	1	post harvest
.75 - 1.0 lb		

   c. **Methods of application:** Dip, drench, ground rig

   d. **Diseases subject to control:**

Common Name	Causal Organism	% Acres Infected	% Yield Loss Without Control
Blossom blight	*M. fructicola*, *M. laxa*	100	
	Botrytis cinerea		
Blue mold	*Penicillium expansum*	100	30-40
Brown rot	*M. fructicola*, *M. laxa*	100	30-40
Cytospora	*Cytospora*		
Grey mold	*Botrytis cinerea*	100	30-40
Leaf spot	*Coecomyces niemalis*		
Powdery mildew	*Podosphaera oxyacanthae*	100	5-10

   e. **Normal (appropriate or typical) management practices using chemical and non-chemical control:** Fungicide sprays, dips

   f. **Alternative fungicides:** WA - TBZ, captan, rovral.
   CA & OR - Captan, DCNA, iprodione, vinclozolin, triforine, chlorothalonil.
   CO - Thiabendazole
   UT - Sulfur

5. DISEASE MANAGEMENT STRATEGIES:

a. **Resistance management:** Benomyl resistance in Monilinia spp. requires companion product, generally captan.

b. **Management practices using no chemical pesticides:** Careful fruit handling, hydrocooling sanitation.

c. **Diseases without adequate controls:**

COMMODITY Sweet Cherries *Prunus avium*
Tart Cherries *Prunus syringae*

GEOGRAPHIC PRODUCTION AREAS Western States

1. **ACRES PLANTED:** 37,126

2. **ACRES HARVESTED:** 37,126

3. **ACRES TREATED:** 28 - 100%

4. **FUNGICIDE** Captan

   a. **Formulations:** 50W,

   b. **Federal/State recommendations or guidelines:**

Rate (ai/A)	No. of Applications	Timing range or avg.
25 lbs/100 gal	1	post-harvest
3 - 8 lb	1 - 5	delayed dormant to post-harvest

   c. **Methods of application:** Dip, ground rig

   d. **Diseases subject to control:**

Common Name	Causal Organism	% Acres Infected	% Yield Loss Without Control
Blossom blight	*M. fructicola*, *M. laxa* *Botrytis cinerea*	100	
Brown rot	*M. fructicola*, *M. laxa*	100	
Cytospora	*Cytospora*	100	
Leaf spot	*Coecomyces niemalis*		
Blue mold	*Penicillium expansum*	100	

   e. **Normal (appropriate or typical) management practices using chemical and non-chemical control:** Chemical control

   f. **Alternative fungicides:** TBZ

5. DISEASE MANAGEMENT STRATEGIES:

a. **Resistance management:** Use of benomyl requires use of companion product for control of Monilinia spp.

b. **Management practices using no chemical pesticides:** Cultural practices, shield harvested fruit from sun and heat; clean, dry bins; reduce picked fruit exposure to dead plant material and dust.

c. **Diseases without adequate controls:**

FUNGICIDE BENEFITS REPORT

COMMODITY Sweet Cherry Prunus avium
Tart Cherry Prunus syringae

GEOGRAPHIC PRODUCTION AREAS Western States

1. ACRES PLANTED: 37,126

2. ACRES HARVESTED: 37,126

3. ACRES TREATED: 29 - 50%

4. FUNGICIDE Chlorothalonil

a. Formulations: Bravo 4F, 720

b. Federal/State recommendations or guidelines:

Rate (ai/A)	No. of Applications	Timing range or avg.
2.3 - 4.2 lbs	1 - 2	pre-bloom

c. Methods of application: Ground rig

d. Diseases subject to control:

Common Name	Causal Organism	% Acres Infected	% Yield Loss Without Control
Brown rot	Monilinia fructicola	100	50-70%
Coryneum blight	Stigmina carpophila		
Leaf curl	Taphrina ceras		

e. Normal (appropriate or typical) management practices using chemical and non-chemical control: Chemical control

f. Alternative fungicides: CA, OR: captan, iprodione, vinclozolin, triforine, benomyl, sulfur
ID: copper
WA: TBZ

5. DISEASE MANAGEMENT STRATEGIES:

a. Resistance management: No resistance known to chlorothalonil

b. Management practices using no chemical pesticides: Cultural practices

c. Diseases without adequate controls:

FUNGICIDE BENEFITS REPORT

COMMODITY Sweet Cherry Prunus avium
Tart Cherry Prunus syringae

GEOGRAPHIC PRODUCTION AREAS Western States

1. ACRES PLANTED: 37,126

2. ACRES HARVESTED: 37,126

3. ACRES TREATED: 20 - 90%

4. FUNGICIDE Sulfur

a. Formulations: WP, F, DF

b. Federal/State recommendations or guidelines:

Rate (ai/A)	No. of Applications	Timing range or avg.
3 - 5 lbs	1 - 3	late bloom, every two weeks, shuck fall

c. Methods of application: Blower

d. Diseases subject to control:

Common Name	Causal Organism	% Acres Infected	% Yield Loss Without Control
Powdery mildew	Podosphaera oxyacanthae	100	25

e. Normal (appropriate or typical) management practices using chemical and non-chemical control: Fungicide sprays

f. Alternative fungicides: Benomyl

5. DISEASE MANAGEMENT STRATEGIES:

a. Resistance management: No resistance to sulfur known.

b. Management practices using no chemical pesticides: None

c. Diseases without adequate controls:

Fungicide Benefits on Citrus (*Citrus aurantifolia*, lime)
(*C. sinesis*, Orange) (*C. paradisi*, Grapefruit)
(C. lemon, lemon) (*C. reticulatis*, Tangerine)

Commercial citrus production in the United States is confined to California, Arizona, Texas and Florida. Total U.S. acreage in 1988 was 832,400. Arizona production makes up 4.4 percent of the total with an annual crop value of approximately $59,889,000. California's 249,700 acres accounts for 30 percent of the U.S. acreage with a value of $728,699,000. Florida production accounts for 62.8 percent of the national with a crop value of $1,708,906,000. Texas produces 23,100 acres of citrus (2.7%) worth $39,226,000. Citrus acreage is comprised of oranges with navel oranges accounting for 37.5 percent of the crop and valencia oranges accounting for 31.5 percent of the total citrus production. Grapefruit acreage accounts for 17.7 percent of U.S. citrus, while lemons, limes, tangelos, tangerines and temples account for 7.8, .08, 1.1, 2.3 and 1.1 percent, respectively.

Diseases occurring in the field include root rots and fruit infection or contamination which later is expressed as fruit rots in storage.

Table 7. CITRUS FRUITS

CROP, SEASON AND STATE	BEARING ACREAGE	PRODUCTION	UTILIZATION OF PRODUCTION:		VALUE OF PRODUCTION
			FRESH	PROCESSED	
	ACRES		1,000 TONS		1,000 DOLS
Oranges					
Early,Mid-season & Navel					
1985-86	298600	4159	1252	2907	623506
1986-87	304500	4314	1283	3031	687930
1987-88	312400	4777	1255	3522	878058
Valencia					
1985-86	263000	3328	868	2460	468719
1986-87	263100	3383	787	2596	634693
1987-88	262200	3680	871	2809	823421
All Oranges					
1985-86	561600	7487	2120	5367	1092225
1986-87	567600	7697	2070	5627	1322623
1987-88	574600	8457	2126	6331	1701479
Grapefruit					
1985-86	145200	2339	1079	1260	340012
1986-87	146100	2568	1188	1380	412234
1987-88	147400	2781	1329	1452	471558
Lemons					
1985-86	65300	697	436	261	219270
1986-87	66300	1087	469	618	182076
1987-88	65300	785	459	326	202854
Limes					
1985-86	6800	76	39	37	21901
1986-87	6700	63	37	26	19569
1987-88	7000	57	38	19	23314
Tangelos					
1985-86	9500	133	60	73	19141
1986-87	9500	180	59	121	24626
1987-88	9300	189	63	126	32687
Tangerines 1/					
1984-85	23200	176	108	68	60454
1985-86	20600	186	124	62	58979
1986-87	19300	220	151	69	67290
1987-88	19300	212	148	64	78197

Citrus Fruits,
September 1988

Agricultural Statistics Board,
NASS, USDA

CITRUS FRUITS

CROP, SEASON AND STATE	BEARING ACREAGE ACRES	PRODUCTION	UTILIZATION OF PRODUCTION: FRESH 1,000 TONS	UTILIZATION OF PRODUCTION: PROCESSED	VALUE OF PRODUCTION 1,000 DOLS
Temples					
1985-86	10000	133	41	92	16052
1986-87	9400	153	47	106	20513
1987-88	9500	160	58	102	26631
Total Citrus					
Arizona					
1984-85 2/	38400	443	247	196	76404
1985-86	36500	313	214	99	84472
1986-87	37400	467	227	240	65618
1987-88	36500	272	174	98	59889
California					
1984-85 2/	254445	3069	2117	952	730629
1985-86	252900	2930	2232	698	616598
1986-87	251200	3377	2197	1180	668962
1987-88	249700	3136	2235	901	728699
Florida 1/ 3/					
1984-85	575900	7013	1120	5893	1269823
1985-86	507800	7785	1433	6352	1061266
1986-87	514500	8009	1501	6508	1290999
1987-88	523100	9020	1646	7374	1708906
Texas					
1984-85 4/	30490	0	0	0	0
1985-86	21800	23	20	3	5244
1986-87	21800	115	96	19	23352
1987-88	23100	213	166	47	39226
U S 1/ 3/					
1984-85 2/	899235	10525	3484	7041	2076856
1985-86	819000	11051	3899	7152	1767580
1986-87	824900	11968	4021	7947	2048931
1987-88	832400	12641	4221	8420	2536720

1/ PER PROGRAM MODIFICATION, FLORIDA "ALL TANGERINES" INCLUDE HONEY TANGERINES BEGINNING WITH THE 1987-88 CROP YEAR. ESTIMATES STARTING WITH THE 1984-85 SEASON HAVE BEEN REVISED TO INCLUDE THE HONEY VARIETY.

2/ VALUE OF PRODUCTION REVISED DUE TO CHANGES IN COST FROM FOB TO PHD.

3/ DOES NOT INCLUDE LEMONS AND K-EARLY CITRUS FRUIT.

4/ DUE TO THE SEVERE FREEZE OF DECEMBER 1983, NO COMMERCIAL SUPPLIES WERE HARVESTED FOR THE 1984-85 TEXAS CITRUS CROP SEASON.

FUNGICIDE BENEFITS REPORT

COMMODITY Citrus Orange - C. sinensis, Lemon - C. limon, Lime - C. aurantifolia Grapefruit - C. paradisi Tangerine - C. reticulatis

GEOGRAPHIC PRODUCTION AREAS Western States

1. **ACRES PLANTED:** 832,400

2. **ACRES HARVESTED:** 832,400

3. **ACRES TREATED:** 100 % of fruit

4. **FUNGICIDE** Sodium-O-phenyl phenate

   a. **Formulations:** Various

   b. **Federal/State recommendations or guidelines:**

Rate (ai/A)	No. of Applications	Timing range or avg.
2000-3500 ppm	1	in post harvest wash

   c. **Methods of application:** dip

   d. **Diseases subject to control:**

Common Name	Causal Organism	% Acres Infected	% Yield Loss Without Control
Blue & Green Mold	Penicillium spp	100	25
Stem end rot	Diaporthe & Diplodia		

   e. **Normal (appropriate or typical) management practices using chemical and non-chemical control:** Cold storage.

   f. **Alternative fungicides:** Thiabendazole, imazalil

5. DISEASE MANAGEMENT STRATEGIES:

   a. **Resistance management:**

   b. **Management practices using no chemical pesticides:**

   c. **Diseases without adequate controls:**

FUNGICIDE BENEFITS REPORT

COMMODITY Citrus Orange - C. sinensis, Lemon - C. limon, Lime - C. aurantifolia Grapefruit - C. paradisi Tangerine - C. reticulatis

GEOGRAPHIC PRODUCTION AREAS Western States

1. **ACRES PLANTED:** 832,400

2. **ACRES HARVESTED:** 832,400

3. **ACRES TREATED:** 5-15%

4. **FUNGICIDE** Metalaxyl

   a. **Formulations:** Ridomil 2E

   b. **Federal/State recommendations or guidelines:**

Rate (ai/A)	No. of Applications	Timing range or avg.
1 gal/15 gal H_2O	Spray on trunk	2 times a year

   c. **Methods of application:** spray on trunk

   d. **Diseases subject to control:**

Common Name	Causal Organism	% Acres Infected	% Yield Loss Without Control
Foot rot	Phytophthora parasitica	20	2-5

   e. **Normal (appropriate or typical) management practices using chemical and non-chemical control:** Water management.

   f. **Alternative fungicides:** none

5. DISEASE MANAGEMENT STRATEGIES:

   a. **Resistance management:** Resistant root stocks

   b. **Management practices using no chemical pesticides:** High graft unions

   c. **Diseases without adequate controls:**

FUNGICIDE BENEFITS REPORT

COMMODITY Citrus Orange - C. sinensis, Lemon - C. limon, Lime - C. aurantifolia Grapefruit - C. paradisi Tangerine - C. reticulatis

GEOGRAPHIC PRODUCTION AREAS Western States

1. **ACRES PLANTED:** 832,400

2. **ACRES HARVESTED:** 832,400

3. **ACRES TREATED:** All harvested fruit

4. **FUNGICIDE** Thiabendazole

   a. **Formulations:**

   b. **Federal/State recommendations or guidelines:**

Rate (ai/A)	No. of Applications	Timing range or avg.
1000-3000 ppm	1	in post harvest wash

   c. **Methods of application:** dip

   d. **Diseases subject to control:**

Common Name	Causal Organism	% Acres Infected	% Yield Loss Without Control
Blue & Green Mold	Penicillium spp	100	25
Stem end rot	Diaporthe & Diplodia		

   e. **Normal (appropriate or typical) management practices using chemical and non-chemical control:** Cold storage.

   f. **Alternative fungicides:** SOPP (sodium-O-phenyl phenate), imazalid

5. DISEASE MANAGEMENT STRATEGIES:

   a. **Resistance management:**

   b. **Management practices using no chemical pesticides:**

   c. **Diseases without adequate controls:**

FUNGICIDE BENEFITS REPORT

COMMODITY Citrus Orange - C. sinensis, Lemon - C. limon, Lime - C. aurantifolia Grapefruit - C. paradisi Tangerine - C. reticulatis

GEOGRAPHIC PRODUCTION AREAS Western States

1. **ACRES PLANTED:** 832,400

2. **ACRES HARVESTED:** 832,400

3. **ACRES TREATED:** 25%

4. **FUNGICIDE** Copper

   a. **Formulations:** Copper hydroxide, copper sulfate, ethers

   b. **Federal/State recommendations or guidelines:**

Rate (ai/A)	No. of Applications	Timing range or avg.
3-7 lbs	2	

   c. **Methods of application:** Ground spray

   d. **Diseases subject to control:**

Common Name	Causal Organism	% Acres Infected	% Yield Loss Without Control
Melanose	Diaporthe citri	50	15

   e. **Normal (appropriate or typical) management practices using chemical and non-chemical control:** Sprays necessary

   f. **Alternative fungicides:** None

5. DISEASE MANAGEMENT STRATEGIES:

   a. **Resistance management:** None

   b. **Management practices using no chemical pesticides:** dead wood removal

   c. **Diseases without adequate controls:**

FUNGICIDE BENEFITS REPORT

COMMODITY Citrus Orange - C. sinensis, Lemon - C. limon, Lime - C. aurantifolia Grapefruit - C. paradisi Tangerine - C. reticulatis

GEOGRAPHIC PRODUCTION AREAS Western States

1. **ACRES PLANTED:** 832,400

2. **ACRES HARVESTED:** 832,400

3. **ACRES TREATED:** 10%

4. **FUNGICIDE** Copper

   a. **Formulations:** Various formulations

   b. **Federal/State recommendations or guidelines:**

Rate (ai/A)	No. of Applications	Timing range or avg.
3-7 lbs	1	

   c. **Methods of application:** Ground spray

   d. **Diseases subject to control:**

Common Name	Causal Organism	% Acres Infected	% Yield Loss Without Control
Greasy spot	Mycosphaerella citri	5	<.1

   e. **Normal (appropriate or typical) management practices using chemical and non-chemical control:** Treatment usually not necessary.

   f. **Alternative fungicides:** Benomyl

5. DISEASE MANAGEMENT STRATEGIES:

   a. **Resistance management:** None

   b. **Management practices using no chemical pesticides:** disk under leaves

   c. **Diseases without adequate controls:**

FUNGICIDE BENEFITS REPORT

COMMODITY Citrus Orange - C. sinensis, Lemon - C. limon, Lime - C. aurantifolia, Grapefruit - C. paradisi Tangerine - C. reticulatis

GEOGRAPHIC PRODUCTION AREAS Western States

1. **ACRES PLANTED:** 832,400

2. **ACRES HARVESTED:** 832,400

3. **ACRES TREATED:** 1%

4. **FUNGICIDE** Benomyl

   a. **Formulations:** Benlate 50WP

   b. **Federal/State recommendations or guidelines:**

Rate (ai/A)	No. of Applications	Timing range or avg.
1 lb	1	

   c. **Methods of application:** Ground spray

   d. **Diseases subject to control:**

Common Name	Causal Organism	% Acres Infected	% Yield Loss Without Control
Greasy spot	Mycosphaerella citri	5	<.1

   e. **Normal (appropriate or typical) management practices using chemical and non-chemical control:** Treatment usually not necessary.

   f. **Alternative fungicides:** Copper

5. DISEASE MANAGEMENT STRATEGIES:

   a. **Resistance management:** None

   b. **Management practices using no chemical pesticides:** disk under leaves

   c. **Diseases without adequate controls:**

FUNGICIDE BENEFITS REPORT

COMMODITY Citrus Orange - C. sinensis, Lemon - C. limon, Lime - C. aurantifolia, Grapefruit - C. paradisi Tangerine - C. reticulatis

GEOGRAPHIC PRODUCTION AREAS Western States

1. **ACRES PLANTED:** 832,400

2. **ACRES HARVESTED:** 832,400

3. **ACRES TREATED:** All harvested fruit

4. **FUNGICIDE** Biphenyl

   a. **Formulations:** Various

   b. **Federal/State recommendations or guidelines:**

Rate (ai/A)	No. of Applications	Timing range or avg.
impregnated in pads in cartons		

   c. **Methods of application:** in pads

   d. **Diseases subject to control:**

Common Name	Causal Organism	% Acres Infected	% Yield Loss Without Control
Blue & Green Mold	Penicillium spp	100	25
Stem end rot	Diaporthe & Diplodia		

   e. **Normal (appropriate or typical) management practices using chemical and non-chemical control:** Cold storage.

   f. **Alternative fungicides:** Sodium-O-phenyl phenate, thiabendazole, imazalid

5. DISEASE MANAGEMENT STRATEGIES:

   a. **Resistance management:**

   b. **Management practices using no chemical pesticides:**

   c. **Diseases without adequate controls:**

Fungicide Benefits on CRANBERRY (*Vaccinium macrocarpum*)

The production of cranberries is a highly specialized enterprise limited mainly to Massachusetts, New Jersey, and Wisconsin in the eastern United States and to Washington and Oregon in the west. The total U. S. production of 4.0 million barrels, valued at $178.9 million is produced on 25,900 acres. Massachusetts leads in production with 11,800 acres (46% of total) producing 1.9 million barrels and valued at $84.8 million. Wisconsin is second in production with 8,300 acres (32% of total) valued at $64.5 million (Table 8).

Cranberry producers must control at least eight fungal pathogens which cause significant disease loss. Early rot (*Phyllosticta vaccinii*) occurs in all commercial bogs and can cause 100% loss if not controlled. Other diseases that occur commonly can produce losses ranging from 25% to 50%. Disease control is attained through the use of 2-3 fungicide applications timed during the bloom and immediate post-bloom periods. Fungicide sprays are used in conjunction with other control measures including the sanding of bogs and the use of resistant cultivars when possible.

Chlorothalonil is the fungicide most extensively used (75% of acreage) because of its high efficacy against several diseases. Mancozeb was also commonly used (40% of acreage) before registration was withdrawn. Ferbam usage is about the same level as mancozeb, while copper is used on 25% of the acreage. Pathogen populations resistant to the fungicides used have not been detected, most probably because of the limited number of applications per year.

Table 8. Cranberry Bearing Acres and Production in the United States by Regions

State/Region	Bearing Acres-1988	Production Barrels
Northeast		
Massachusetts	11,800	1,910,000
Total	11,800	1,910,000
Northcentral		
Wisconsin	8,300	1,450,000
Total	8,300	1,450,000
Mid-Atlantic		
New Jersey	3,300	370,000
Total	3,300	370,000
West		
Oregon	1,300	154,000
Washington	1,200	135,000
Total	2,500	289,000
Total U.S.	25,900	4,019,000

FUNGICIDE BENEFITS REPORT

COMMODITY Cranberries Vaccinium macrocarpum

GEOGRAPHIC PRODUCTION AREAS Western States

1. **ACRES PLANTED:** 2,500

2. **ACRES HARVESTED:** 2,500

3. **ACRES TREATED:** 80-90%

4. **FUNGICIDE** Chlorothalonil

   a. **Formulations:** Flowable 4F

   b. **Federal/State recommendations or guidelines:**

Rate (ai/A)	No. of Applications	Timing range or avg.
3-5.25 lb	1-2	late bloom - berry development

   c. **Methods of application:** irrigation, ground rig

   d. **Diseases subject to control:**

Common Name	Causal Organism	% Acres Infected	% Yield Loss Without Control
Fruit rot	various	95	20
Twig blight	Lophodermium spp.	5	45

   e. **Normal (appropriate or typical) management practices using chemical and non-chemical control:**

   f. **Alternative fungicides:** Mancozeb

5. DISEASE MANAGEMENT STRATEGIES:

   a. **Resistance management:** Resistance to chlorothalonil is unknown

   b. **Management practices using no chemical pesticides:** none except pruning and fertilization

   c. **Diseases without adequate controls:** Rose bloom

FUNGICIDE BENEFITS REPORT

COMMODITY Cranberries

GEOGRAPHIC PRODUCTION AREAS Western States

1. ACRES PLANTED: 2,500

2. ACRES HARVESTED: 2,500

3. ACRES TREATED: 80-90%

4. FUNGICIDE EBDC

a. Formulations: WP, F

b. Federal/State recommendations or guidelines:

Rate (ai/A)	No. of Applications	Timing range or avg.
2.4-4.8 lb	.5-4 lbs	bloom/post-flowers, pre-harvest

c. Methods of application: irrigation, ground rig

d. Diseases subject to control:

Common Name	Causal Organism	% Acres Infected	% Yield Loss Without Control
Fruit rot	various	95	20
Twig blight	Lophodermium spp.	5	5

e. Normal (appropriate or typical) management practices using chemical and non-chemical control:

f. Alternative fungicides: chlorothalonil, sulfur

5. DISEASE MANAGEMENT STRATEGIES:

a. Resistance management: Resistance to EBDC fungicides is unknown

b. Management practices using no chemical pesticides: none except pruning and fertilization

c. Diseases without adequate controls: Rose bloom

Fungicide Benefits on GRAPES
(*Vitis vinifera*, *V. labrusca*, *V. rotundifolia*)

Grapes are grown commercially or in home plantings in all regions of the United States with commercial production in at least 17 states. Nationally, grapes are the highest valued crop of the noncitrus fruit and nut crops with annual production of 5.8 million tons grown on 757,280 acres and valued at $1.36 billion. California produces 86% of the grapes in the U. S. on 653,700 acres with annual production of 5.2 million tons valued at $1.22 billion. The crop in California is grown for making wine (298,900 acres) and raisins (270,700 acres) or for fresh consumption (84,100 acres). Other grape growing states of importance nationally are New York (35,800 acres), Washington (29,200 acres), Michigan (11,100 acres), and Pennsylvania (10,800) (Table 9). In the eastern regions 68,350 acres valued at $71.2 million are grown for processing into various products (juice, jelly, jams, and concentrates), wine production, and a limited amount for fresh consumption.

Grape disease incidence and severity in the more humid eastern states is higher and requires more extensive use of fungicide sprays for control than in the arid western region. Diseases such as powdery mildew and Botrytis bunch rot are prevalent in all regions, affecting from 30%-100% of the acreage with the potential of causing 45%-60% losses if not controlled. At least seven other fungal pathogens producing fruit decay, leaf spots, and cane blights are prevalent in eastern vineyards affecting from 30%-95% of the acreage with potential losses of up to 85%. Control of these diseases requires the use of three to six applications annually in many vineyards. The diversity of pathogen types in many eastern vineyards necessitates the use of fungicides that control the disease complex present. Benomyl was extensively used because of its broad spectrum of disease activity until resistant populations of the pathogens causing powdery mildew and Botrytis bunch rot developed. Mancozeb, ferbam, and captan are very effective against several diseases and are used as companion fungicides in increasing efficacy of the sterol inhibitor fungicides or in delaying resistance development to benomyl, triadimefon, myclobutanil, or fenarimol.

Table 9. Grapes Bearing Acres and Production in the United States by Regions.

State/Region	Bearing Acres-1988	Production Tons
Northeast		
New York	35,800	157,000
Pennsylvania	10,000	58,000
Rhode Island	300	---
Total	46,100	215,000
NorthCentral		
Arkansas	2,200	7,000
Illinois	150	600
Indiana	500	2,250
Michigan	11,100	53,000
Missouri	1,300	3,250
Ohio	1,900	8,900
Total	17,150	75,000
Mid-Atlantic		
Georgia	1,600	2,500
Maryland	600	1,800
New Jersey	1,000	3,000
North Carolina	700	3,300
South Carolina	500	600
Total	4,400	11,200
West		
Arizona	6,730	28,700
California		
All types	653,700	5,240,000
Wine type	298,900	2,130,000

Table 9. (continued)

Table type	84,100	700,000
Raisin type	270,700	2,410,000
Oregon	3,413	7,719
Washington	29,200	182,000
Total	693,043	5,458,419
Total U.S.	760,693	5,759,619

FUNGICIDE BENEFITS REPORT

COMMODITY Grapes

GEOGRAPHIC PRODUCTION AREAS Western States

1. **ACRES PLANTED:** 701,630

2. **ACRES HARVESTED:** 701,630

3. **ACRES TREATED:** 20%

4. **FUNGICIDE** Captan

   a. **Formulations:** 50W, 50DF

   b. **Federal/State recommendations or guidelines:**

Rate (ai/A)	No. of Applications	Timing range or avg.
1.5-3.0 lbs	1-3	bloom, preclose, veraison

   c. **Methods of application:** Ground rig, air blast, and over vine boom

   d. **Diseases subject to control:**

Common Name	Causal Organism	% Acres Infected	% Yield Loss Without Control
Bunch rot	Botrytis cinerea	100	08-70

   e. **Normal (appropriate or typical) management practices using chemical and non-chemical control:** Leaf removal is an excellent alternative, but in years when fall rains occur, fungicides are required for protection.

   f. **Alternative fungicides:** benomyl, DCNA, iprodione, mancozeb

5. DISEASE MANAGEMENT STRATEGIES:

   a. **Resistance management:** no resistance to captan or mancozeb is known

   b. **Management practices using no chemical pesticides:** leaf removal at cluster set

   c. **Diseases without adequate controls:**

FUNGICIDE BENEFITS REPORT

COMMODITY Grapes Vitis vinifera

GEOGRAPHIC PRODUCTION AREAS Western States

1. **ACRES PLANTED:** 701,630

2. **ACRES HARVESTED:** 701,630

3. **ACRES TREATED:** 18-98%

4. **FUNGICIDE** Benomyl

   a. **Formulations:**

   b. **Federal/State recommendations or guidelines:**

Rate (ai/A)	No. of Applications	Timing range or avg.
.5-1.5 lbs	1-3	bloom, preclose, veraison or immediately after pruning

   c. **Methods of application:** Ground rig, paint or spray

   d. **Diseases subject to control:**

Common Name	Causal Organism	% Acres Infected	% Yield Loss Without Control
Blossom blight	Botrytis cinerea	50	25
Bunch rot	Botrytis cinerea	100	28-70
Eutypa dieback	Eutypa lata	65	20-30

   e. **Normal (appropriate or typical) management practices using chemical and non-chemical control:** Leaf removal Recommend Rovral at 1.5-2.0 #1A at .75-1.0 ai/A at bloom, others at preclose. Prune out infested wood and spray wound with 1% benomyl for Eutypa dieback.

   f. **Alternative fungicides:** OR: iprodione, DCNA, mancozeb CA: captan, iprodione, mancozeb

5. DISEASE MANAGEMENT STRATEGIES:

   a. **Resistance management:** High levels of resistance to benomyl in the Botrytis population - Use of companion fungicide mandatory.

b. **Management practices using <u>no</u> chemical pesticides:** prune disease wood, leaf removal

c. **Diseases <u>without</u> adequate controls:**

FUNGICIDE BENEFITS REPORT

COMMODITY Grapes Vitis vinifera

GEOGRAPHIC PRODUCTION AREAS Western States

1. ACRES PLANTED: 701,630

2. ACRES HARVESTED: 701,630

3. ACRES TREATED: 20%

4. FUNGICIDE Mancozeb

a. Formulations: 50W Dithane

b. Federal/State recommendations or guidelines:

Rate (ai/A)	No. of Applications	Timing range or avg.
	1-4	immediately after bud break for Phomopsis cane and leaf spot

c. Methods of application:

d. Diseases subject to control:

Common Name	Causal Organism	% Acres Infected	% Yield Loss Without Control
Blossom blight	Botrytis cinerea	50	25
Phomopsis cane and Leaf spot	Phomopsis viticola	3-5	1-2
Bunch rot	Botrytis cinerea	100	28-70

e. Normal (appropriate or typical) management practices using chemical and non-chemical control: Leaf removal and/or 1-4 applications of fungicide. Spray one application following bud break - cane-leaf spot

f. Alternative fungicides: OR: iprodione, DCNA, CA: captan, benomyl, iprodione

5. DISEASE MANAGEMENT STRATEGIES:

a. Resistance management: no resistance to mancozeb

b. Management practices using no chemical pesticides: leaf removal at cluster set

c. Diseases without adequate controls:

FUNGICIDE BENEFITS REPORT

COMMODITY Grapes Vitis vinifera

GEOGRAPHIC PRODUCTION AREAS Western States

1. **ACRES PLANTED:** 701,630

2. **ACRES HARVESTED:** 701,630

3. **ACRES TREATED:** 30%

4. **FUNGICIDE** Myclobutanil

   a. **Formulations:** 40W

   b. **Federal/State recommendations or guidelines:**

Rate (ai/A)	No. of Applications	Timing range or avg.
1 - 4 oz.	3 - 5	10" shoot growth, & 10 - 17 day intervals

   c. **Methods of application:** Ground rig

   d. **Diseases subject to control:**

Common Name	Causal Organism	% Acres Infected	% Yield Loss Without Control
Powdery mildew	Uncinula necator	100	80

   e. **Normal (appropriate or typical) management practices using chemical and non-chemical control:** Begin season with 1-3 wettable sulfur applications then switch to DMI at 10" shoot growth, 10-17 day intervals, 4-5 applications

   f. **Alternative fungicides:** Sulfur, fenarimol

5. DISEASE MANAGEMENT STRATEGIES:

   a. **Resistance management:** Resistance to triadimefon, myclobutanil and fenarimol has occurred in California. In vineyards where resistance occurs, tank-mixing with sulfur mandatory for economic control.

   b. **Management practices using no chemical pesticides:** Leaf removal, reduce canopy RH.

   c. **Diseases without adequate controls:**

FUNGICIDE BENEFITS REPORT

COMMODITY Grapes Vitis vinifera

GEOGRAPHIC PRODUCTION AREAS Western States

1. **ACRES PLANTED:** 701,630

2. **ACRES HARVESTED:** 701,630

3. **ACRES TREATED:** 20%

4. **FUNGICIDE** Triadimefon

   a. **Formulations:** 50W, 50DF

   b. **Federal/State recommendations or guidelines:**

Rate (ai/A)	No. of Applications	Timing range or avg.
1 - 4 oz.	3 - 5	10" shoot growth, & 10 - 17 day intervals

   c. **Methods of application:** Ground rig

   d. **Diseases subject to control:**

Common Name	Causal Organism	% Acres Infected	% Yield Loss Without Control
Powdery mildew	Uncinula necator	100	80

   e. **Normal (appropriate or typical) management practices using chemical and non-chemical control:** Begin season with 1-3 wettable sulfur applications then switch to DMI at 10" shoot growth, 10-17 day intervals, 4-5 applications

   f. **Alternative fungicides:** Myclobutanil, sulfur, fenarimol

5. DISEASE MANAGEMENT STRATEGIES:

   a. **Resistance management:** Resistance to triadimefon, myclobutanil and fenarimol has occurred in California. In vineyards where resistance occurs, tank-mixing with sulfur mandatory for economic control.

   b. **Management practices using no chemical pesticides:** Leaf removal, reduce canopy RH.

   c. **Diseases without adequate controls:**

FUNGICIDE BENEFITS REPORT

COMMODITY Grapes Vitis vinifera

GEOGRAPHIC PRODUCTION AREAS Western States

1. ACRES PLANTED: 701,630

2. ACRES HARVESTED: 701,630

3. ACRES TREATED: 30%

4. FUNGICIDE Fenarimol

a. Formulations: 50W, 50DF

b. Federal/State recommendations or guidelines:

Rate (ai/A)	No. of Applications	Timing range or avg.
3 - 6 oz.	3 - 5	10" shoot growth, & 10 - 17 day intervals

c. Methods of application: Ground rig

d. Diseases subject to control:

Common Name	Causal Organism	% Acres Infected	% Yield Loss Without Control
Powdery mildew	Uncinula necator	100	80

e. Normal (appropriate or typical) management practices using chemical and non-chemical control: Begin season with 1-3 wettable sulfur applications then switch to DMI at 10" shoot growth, 10-17 day intervals, 4-5 applications

f. Alternative fungicides: Triadimefon, sulfur, fenarimol

5. DISEASE MANAGEMENT STRATEGIES:

a. Resistance management: Resistance to triadimefon, myclobutanil and fenarimol has occurred in California. In vineyards where resistance occurs, tank-mixing with sulfur mandatory for economic control.

b. Management practices using no chemical pesticides: Leaf removal, reduce canopy RH.

c. Diseases without adequate controls:

FUNGICIDE BENEFITS REPORT

COMMODITY Grapes Vitis vinifera

GEOGRAPHIC PRODUCTION AREAS Western States

1. **ACRES PLANTED:** 701,630

2. **ACRES HARVESTED:** 701,630

3. **ACRES TREATED:** 80%

4. **FUNGICIDE** Sulfur

   a. **Formulations:** WP, Dusting, various

   b. **Federal/State recommendations or guidelines:**

Rate (ai/A)	No. of Applications	Timing range or avg.
4- 8 lbs.	10 - 14	10" shoot growth, & 7 - 10 day intervals

   c. **Methods of application:** Ground rig

   d. **Diseases subject to control:**

Common Name	Causal Organism	% Acres Infected	% Yield Loss Without Control
Powdery mildew	Uncinula necator	100	80

   e. **Normal (appropriate or typical) management practices using chemical and non-chemical control:** Begin season with 1-3 wettable sulfur applications then switch to dusting sulfur and remain on 7-10 interval until veraison in wine and raisin grapes and until harvest in table grapes.

   f. **Alternative fungicides:** Myclobutanil, fenarimol, triadimefon

5. DISEASE MANAGEMENT STRATEGIES:

   a. **Resistance management:** Resistance to triadimefon, myclobutanil and fenarimol has occurred in California. In vineyards where resistance occurs, tank-mixing with sulfur mandatory for economic control.

   b. **Management practices using no chemical pesticides:** Leaf removal, reduce canopy RH.

   c. **Diseases without adequate controls:**

Fungicide Benefits on Kiwifruit. (Actindia deliciosa)

Kiwifruit production in the Western U.S. is confined to California's central and coastal valleys. Approximately 6,700 acres produce 31,000 tons of fruit which is utilized primarily by fresh market. Kiwifruit was introduced into California in 1969 and has relatively few disease problems. Two of the most prevalent diseases are root and crown rots caused by several species of Phytophthora and Botrytis fruit rot which occurs in cold storage. Being a new, minor crop, few fungicides are registered for use.

FUNGICIDE BENEFITS REPORT

COMMODITY Kiwifruit Actinidia deliciosa

GEOGRAPHIC PRODUCTION AREAS Western States

1. **ACRES PLANTED:** 6,700

2. **ACRES HARVESTED:** 6,700

3. **ACRES TREATED:** 50%

4. **FUNGICIDE** Vinclozolin

   a. **Formulations:** Ronilan 50W

   b. **Federal/State recommendations or guidelines:**

Rate (ai/A)	No. of Applications	Timing range or avg.
.75-1.5 lbs	1-2	bloom

   c. **Methods of application:** Ground rig, air blast

   d. **Diseases subject to control:**

Common Name	Causal Organism	% Acres Infected	% Yield Loss Without Control
Blossom blight	Botrytis cinerea	60	10-15
Fruit rot	Botrytis cinerea	100	25-40

   e. **Normal (appropriate or typical) management practices using chemical and non-chemical control:** Foliar spray at bloom

   f. **Alternative fungicides:** None

5. DISEASE MANAGEMENT STRATEGIES:

   a. **Resistance management:** None reported for Botrytis in Kiwifruit

   b. **Management practices using no chemical pesticides:** Canopy management to allow for increased air flow

   c. **Diseases without adequate controls:** Bacterial blight

FUNGICIDE BENEFITS REPORT

COMMODITY Kiwifruit Actinidia deliciosa

GEOGRAPHIC PRODUCTION AREAS Western States

1. ACRES PLANTED: 6,700

2. ACRES HARVESTED: 6,700

3. ACRES TREATED: 35%

4. FUNGICIDE Metalaxyl - Section 18

a. Formulations: Ridomil 2E

b. Federal/State recommendations or guidelines:

Rate (ai/A)	No. of Applications	Timing range or avg.
1-2 ml/tree	3	spring, fall, winter

c. Methods of application: crown drench

d. Diseases subject to control:

Common Name	Causal Organism	% Acres Infected	% Yield Loss Without Control
Root/Crown rot	Phytophthora spp	35	proportional to number of vines affected. Fruit on infected vines non-marketable.
Fruit rot	Botrytis cinerea	100	

e. Normal (appropriate or typical) management practices using chemical and non-chemical control: Treatment in fall, winter, spring as a soil drench around crown.

f. Alternative fungicides: None

5. DISEASE MANAGEMENT STRATEGIES:

a. Resistance management: None

b. Management practices using no chemical pesticides: Decrease irrigation duration, plant on beams

c. Diseases without adequate controls:

Fungicide Benefits on Macadamia Nuts (*Macadamia integrifolia*)

Macadamia nuts are grown commercially on approximately 21,900 acres in Hawaii. Benomyl is used to control blossom blight caused by *Botrytis cinerea*. Approximately 0.5 percent of the acreage is affected resulting in 25 percent loss if not control was practiced. There are no alternative fungicides for this disease, and management practices not using fungicides do not exist.

FUNGICIDE BENEFITS REPORT

COMMODITY Macadamia Nuts Macadamia integrifolia

GEOGRAPHIC PRODUCTION AREAS Western States

1. **ACRES PLANTED:** 21,900

2. **ACRES HARVESTED:** 21,900

3. **ACRES TREATED:** 0.5%

4. **FUNGICIDE** Benomyl

   a. **Formulations:** 50W, 50DF

   b. **Federal/State recommendations or guidelines:**

Rate (ai/A)	No. of Applications	Timing range or avg.
.75 lb	2 - 3	bud formation

   c. **Methods of application:** Mist blower

   d. **Diseases subject to control:**

Common Name	Causal Organism	% Acres Infected	% Yield Loss Without Control
Blossom blight	Botrytis cinerea	0.5	25

   e. **Normal (appropriate or typical) management practices using chemical and non-chemical control:** Benomyl applied 1-2 weeks prior to bloom.

   f. **Alternative fungicides:** None

5. DISEASE MANAGEMENT STRATEGIES:

   a. **Resistance management:** None

   b. **Management practices using no chemical pesticides:** None

   c. **Diseases without adequate controls:**

Fungicide Benefits on Mango (*Mangifera indica*)

Mango is a tropical fruit grown primarily in Hawaii though minor plantings exist in California and Texas. Powdery mildew caused by *Oidium caricae* or *Erysiphe sp*. is a serious disease of mango and results in 100 percent loss of the crop when not controlled. Benomyl is applied 2-3 times per year at the rate of .75 ai/A for control. The alternative fungicide listed is captan. While captan is a good material against many diseases, it has little efficacy against the powdery mildews, and in my opinion cannot be looked upon as a true alternative.

FUNGICIDE BENEFITS REPORT

COMMODITY Mangos Mangifera indica

GEOGRAPHIC PRODUCTION AREAS Western States

1. ACRES PLANTED: 600

2. ACRES HARVESTED: 600

3. ACRES TREATED: 100%

4. FUNGICIDE Benomyl

a. Formulations: DF

b. Federal/State recommendations or guidelines:

Rate (ai/A)	No. of Applications	Timing range or avg.
.75 lbs	2	panicles (2" long)

c. Methods of application: blower

d. Diseases subject to control:

Common Name	Causal Organism	% Acres Infected	% Yield Loss Without Control
Powdery mildew	Oidium caricae	100	100

e. Normal (appropriate or typical) management practices using chemical and non-chemical control:

f. Alternative fungicides: Captan

5. DISEASE MANAGEMENT STRATEGIES:

a. Resistance management:

b. Management practices using no chemical pesticides: None

c. Diseases without adequate controls:

Fungicide Benefits for Pistachio Nuts (*Pistachia vera*)

Pistachios are grown commercially in California with minor production in Arizona. Total bearing acreage in the Western U.S. is 54,120 acres. Two diseases are of extreme importance to the Pistachio industry: blossom blight caused by *Botrytis cinerea* and shoot blight caused by *Botryosphaeria dothidea*. Control of blossom blight has been achieved by use of benomyl at the rate of .75-1.0 lb ai per acre at bloom. Shoot blight also is partially controlled by benomyl though not registered, and use patterns different.

Pistachios are grown throughout the Central Valley of California. Those in the Sacramento Valley portion of the Central Valley are more susceptible to disease from foliar pathogens because of more frequent wet periods. Thus, when 10-50 percent acreage is noted, it reflects the location and weather.

Table 10. Nut Bearing Acres and Production in United States in 1988.

State	Crop	Bearing Acres-1988	Production 1,000 lbs
California	Almonds	406,000	580,000
Total		406,000	580,000[1]
Oregon	Filberts	26,100	16,300
Washington	Filberts	400	200
Total		26,500	16,500[2]
California	Walnuts (English)	176,400	200,000
Total		176,400	200,000[2]
			1,000 lbs
Hawaii	Macadamia	16,600	47,000
Total		16,600	47,000[2]
California	Pistachios	44,500	92,000
Total		44,500	92,000[2]
Alabama	Pecans		11,000
Arkansas	Pecans		3,000
California 2/	Pecans		2,000
Florida	Pecans		5,800
Georgia	Pecans		110,000
Louisiana	Pecans		30,000
Mississippi	Pecans		13,000
New Mexico	Pecans		26,000
North Carolina	Pecans		3,500
Oklahoma	Pecans		27,000
South Carolina	Pecans		4,500
Texas	Pecans		43,000
Total			278,800[2]

[1] Shelled Basis
[2] In-shell Basis

FUNGICIDE BENEFITS REPORT

COMMODITY Pistachios *Pistachia vera*

GEOGRAPHIC PRODUCTION AREAS Western States

1. **ACRES PLANTED:** 54,120

2. **ACRES HARVESTED:** 54,120

3. **ACRES TREATED:** 10-50% (depending on location in State)

4. **FUNGICIDE** benomyl

   a. **Formulations:** Benlate 50W/50DF

   b. **Federal/State recommendations or guidelines:**

Rate (ai/A)	No. of Applications	Timing range or avg.
.75-1.0 lb	1	Bloom

   c. **Methods of application:** Ground rig, air blast

   d. **Diseases subject to control:**

Common Name	Causal Organism	% Acres Infected	% Yield Loss Without Control
Blossom blight	*Botrytis cinerea*	25-30	50
Shoot blight	*Botryosphaeria dothidea*	40	40-50

   e. **Normal (appropriate or typical) management practices using chemical and non-chemical control:**

   f. **Alternative fungicides:** none

5. DISEASE MANAGEMENT STRATEGIES:

   a. **Resistance management:** none

   b. **Management practices using no chemical pesticides:** For shoot blight, lower the trajectory of the sprinklers to prevent wetting of foliage.

   c. **Diseases without adequate controls:** Shoot blight.

FUNGICIDE BENEFITS REPORT

COMMODITY Pistachios Pistachia vera

GEOGRAPHIC PRODUCTION AREAS Western States

1. ACRES PLANTED: 54,120

2. ACRES HARVESTED: 54,120

3. ACRES TREATED: 10-50%

4. FUNGICIDE Copper

a. Formulations: Kocide 101

b. Federal/State recommendations or guidelines:

Rate (ai/A)	No. of Applications	Timing range or avg.
4-8 lbs	1-3	preharvest, 10-15 days

c. Methods of application: Ground rig

d. Diseases subject to control:

Common Name	Causal Organism	% Acres Infected	% Yield Loss Without Control
Fruit rot	Alternaria alternata	10-50	25

e. Normal (appropriate or typical) management practices using chemical and non-chemical control: Sprays are applied 10-15 days preharvest, 1-3 sprays required depending on weather and location.

f. Alternative fungicides: none

5. DISEASE MANAGEMENT STRATEGIES:

a. Resistance management: none

b. Management practices using no chemical pesticides: Pruning of affected nut clusters.

c. Diseases without adequate controls: Shoot blight.

FUNGICIDE BENEFITS REPORT

COMMODITY Walnuts

GEOGRAPHIC PRODUCTION AREAS Western States

1. **ACRES PLANTED:** 450,000

2. **ACRES HARVESTED:** 402,000

3. **ACRES TREATED:** 80%

4. **FUNGICIDE** Copper

   a. **Formulations:** Various

   b. **Federal/State recommendations or guidelines:**

Rate (ai/A)	No. of Applications	Timing range or avg.
3 lb	0-10	3-7 day intervals

   c. **Methods of application:** airblast sprayer

   d. **Diseases subject to control:**

Common Name	Causal Organism	% Acres Infected	% Yield Loss Without Control
Walnut blight	Xanthomonas juglandis	50	10-90

   e. **Normal (appropriate or typical) management practices using chemical and non-chemical control:** Copper is applied pre-bloom when catkins are extended but not shedding pollen, second spray at bloom.

   f. **Alternative fungicides:** None

5. DISEASE MANAGEMENT STRATEGIES:

   a. **Resistance management:** None

   b. **Management practices using no chemical pesticides:** None

   c. **Diseases without adequate controls:**

Fungicide Benefits on Papaya (*Carica papaya*)

Papaya is grown on 2,300 acres in Hawaii. Fruit infection by *Phytophthora spp.* is the disease of primary concern. Mancozeb is used for control at the rate of 2.25 lbs ai/A. Up to 17 applications are made using spray intervals of 7-14 days when weather conditions conducive for disease increase exist. The alternative fungicide is copper sulfate. Chlorothalonil is not a viable alternative for papaya exported from Hawaii. Current quarantine treatments for exported fruit include a double hot water dip or vapor heat. Fruit treated with chlorothalonil prior to hot water or vapor treatments scald and becomes unmarketable.

FUNGICIDE BENEFITS REPORT

COMMODITY Papayas Carica papaya

GEOGRAPHIC PRODUCTION AREAS Western States

1. **ACRES PLANTED:** 2300

2. **ACRES HARVESTED:** 2300

3. **ACRES TREATED:** 100%

4. **FUNGICIDE** Mancozeb

   a. **Formulations:** Wettable

   b. **Federal/State recommendations or guidelines:**

Rate (ai/A)	No. of Applications	Timing range or avg.
2.25 lbs	17	7-14 days

   c. **Methods of application:** Sprayer

   d. **Diseases subject to control:**

Common Name	Causal Organism	% Acres Infected	% Yield Loss Without Control
Phytophthora	infections	100	100

   e. **Normal (appropriate or typical) management practices using chemical and non-chemical control:** Mancozeb is essential for production.

   f. **Alternative fungicides:** Chlorothalonil except for export, copper sulfate

5. DISEASE MANAGEMENT STRATEGIES:

   a. **Resistance management:**

   b. **Management practices using no chemical pesticides:** None

   c. **Diseases without adequate controls:** Phytophthora, colletotrichum (anthracnose)

Fungicide Benefits on PEACH/NECTARINE
Peach (*Prunus persica*) and Nectarine (*Prunus persica nectaria*)

Peach and nectarine are the third most valued noncitrus fruit or nut crop grown in the United States. Annual production of these crops is 1.4 million tons (fresh equivalent) grown on 190,100 acres and valued at $474 million. They are grown commercially in 21 eastern states with acreage of 105,800 acres and in six western states with 84,300 acres (Table 11). Leading producing states are California (76,500 acres), South Carolina (33,500 acres), Georgia (19,000 acres), New Jersey (11,000 acres), Michigan (7,600 acres), and Pennsylvania (7,600 acres). California produces a major portion of the nectarines (23,600 acres) and cling stone peaches (28,300 acres) grown in the U.S. In the east, 10 mid-Atlantic states produce 84,300 acres, eight northcentral states produce 18,600 acres and 2,900 acres are grown in three northeastern states.

The application of fungicides is necessary in all regions where eight or more fungal and two bacterial pathogens commonly occur. The incidence and severity of each disease varies with the environmental conditions in each region, thus more intensive fungicide usage is essential in the more humid eastern orchards. Brown rot is prevalent in both eastern and western orchards and may produce 75%-90% loss if not controlled. Peach scab incidence varies from 50%-100% in the mid-Atlantic states where losses may be as high as 50%. Two major bacterial diseases that produce branch cankers, defoliation, and fruit spots in some eastern orchards can cause losses of 10%-50% if not controlled.

Fungicide usage programs in the east are designed for control of brown rot, peach scab, powdery mildew, Rhizopus rot, and leaf curl. To control this disease complex, two or more fungicides must be tank mixed and specific fungicides selected for specific disease problems. Protective fungicides such as captan, ferbam, sulfur, and copper may be used for specific diseases, but are more effective against disease complexes if combined with a benzimidazole, dicarboximide, or sterol- inhibitor fungicide. Mixtures are commonly used to delay resistance development as well as to improve efficacy. The control of several diseases require from two to eight fungicide applications annually, but growers seldom use a single fungicide for the entire season. Ferbam, chlorothalonil, and copper are effective against leaf curl and may not be used more than in a single application, although chlorothalonil may be used effectively against brown rot blossom blight if used in two to three applications during bloom. Because of phytotoxicity to leaves this fungicide is not used during the summer sprays.

Table 11. Peach/Nectarine Acres and Production in the United States by Regions

State/Region	Bearing Acres-1988	Production Million lb. 1988
Northeast		
Connecticut	500	2.7
Massachusetts	300	2.2
New York	2,100	14.1
Total	2,900	19.0
NorthCentral		
Arkansas	1,900	20.0
Illinois	2,300	20.0
Indiana	1,100	4.5
Kansas	900	4.5
Kentucky	1,200	6.0
Michigan	7,600	45.0
Missouri	2,700	14.4
Ohio	900	6.0
Total	18,600	120.4
Mid-Atlantic		
Delaware	300	3.1
Georgia	19,000	140.0
Maryland	2,500	12.8
New Jersey	11,000	85.0
North Carolina	3,400	36.0
Pennsylvania	7,600	85.0
South Carolina	33,500	340.0
Tennessee	1,500	11.0
Virginia	2,300	29.0
West Virginia	3,200	20.0
Total	84,300	761.9
West		
California		
Clingstone	28,300	1015.0
Freestone	24,600	523.0
Nectarine	23,600	400.0
Colorado	1,500	16.0
Idaho	700	11.8
Oregon	1,400	14.0
Utah	1,600	11.0

Table 11. (continued)

Washington	2,600	50.0
Total	84,300	2,040.8
Total U.S.	190,100	2,942.1

FUNGICIDE BENEFITS REPORT

COMMODITY Peaches Prunus persica, Nectarines Prunus persica var. Nectaria

GEOGRAPHIC PRODUCTION AREAS Western States

1. ACRES PLANTED: 84,300

2. ACRES HARVESTED: 84,300

3. ACRES TREATED: 1-33%

4. FUNGICIDE benomyl

a. Formulations: Benlate 50DF, 50WP

b. Federal/State recommendations or guidelines:

Rate (ai/A)	No. of Applications	Timing range or avg.
.001-.75 lb	1-3	spring (bloom) or summer (preharvest)

c. Methods of application: Ground rig, air blast

d. Diseases subject to control:

Common Name	Causal Organism	% Acres Infected	% Yield Loss Without Control
Brown rot	M. fructicola, M. laxa	100	75
Cytospora	Cytospora leucostoma	5-10	100
Powdery mildew	Sphaerotheca parmosa	15	5-10
Rusty spot		15	

e. Normal (appropriate or typical) management practices using chemical and non-chemical control: Fungicide applications at bloom (1-2) and preharvest if rain conditions exist.

f. Alternative fungicides: captan, DCNA, iprodione, vinclozolin, triforine, thiabendazole, sulfur, dinocap

5. DISEASE MANAGEMENT STRATEGIES:

a. Resistance management: Resistance to benomyl is extensive, companion product mandatory as tank mix.

b. Management practices using no chemical pesticides: Cultivation and removal of mummies for brown rot.

c. Diseases without adequate controls:

FUNGICIDE BENEFITS REPORT

COMMODITY Peaches Prunus persica, Nectarines Prunus persica var. Nectaria

GEOGRAPHIC PRODUCTION AREAS Western States

1. ACRES PLANTED: 84,300

2. ACRES HARVESTED: 84,300

3. ACRES TREATED: 15-80%

4. FUNGICIDE Captan

   a. Formulations: Captan 50WP

   b. Federal/State recommendations or guidelines:

Rate (ai/A)	No. of Applications	Timing range or avg.
2.0-12.0 lb	1-4	pre-bloom, summer/post-harvest
	1-2	Autumn - coryneum blight

   c. Methods of application: Ground rig

   d. Diseases subject to control:

Common Name	Causal Organism	% Acres Infected	% Yield Loss Without Control
Brown rot	M. fructicola, M. laxa	100	75
Coryneum blight (shot hole)	Stigmina carpophila	25	5-10

   e. Normal (appropriate or typical) management practices using chemical and non-chemical control: Fungicide applications at bloom 1-2 and preharvest if rain conditions exist.

   f. Alternative fungicides: benomyl, DCNA, iprodione, vinclozolin, triforine, ziram, copper, sulfur, chlorothalonil

5. DISEASE MANAGEMENT STRATEGIES:

   a. Resistance management: Resistance to captan unknown in Monilinia spp., and Stigmina carpophila

   b. Management practices using no chemical pesticides: None

   c. Diseases without adequate controls:

FUNGICIDE BENEFITS REPORT

COMMODITY Peaches Prunus persica, Nectarines Prunus persica var. Nectaria

GEOGRAPHIC PRODUCTION AREAS Western States

1. **ACRES PLANTED:** 84,300

2. **ACRES HARVESTED:** 84,300

3. **ACRES TREATED:** 50-71%

4. **FUNGICIDE** chlorothalonil

   a. **Formulations:** Bravo 4F

   b. **Federal/State recommendations or guidelines:**

Rate (ai/A)	No. of Applications	Timing range or avg.
.2-3.13 lb	1-2	pre-bloom/post-harvest

   c. **Methods of application:** dip, air blast

   d. **Diseases subject to control:**

Common Name	Causal Organism	% Acres Infected	% Yield Loss Without Control
Brown rot	M. fructicola, M. laxa	100	75
Shot hole	Stigmina carpophila	25	proportional to twig dieback

   e. **Normal (appropriate or typical) management practices using chemical and non-chemical control:**

   f. **Alternative fungicides:** iprodione, vinclozolin, triforine, benomyl, sulfur, copper, fixed coppers, ziram

5. DISEASE MANAGEMENT STRATEGIES:

   a. **Resistance management:** Resistance to chlorothalonil unknown

   b. **Management practices using no chemical pesticides:** none

   c. **Diseases without adequate controls:**

FUNGICIDE BENEFITS REPORT

COMMODITY Peaches Prunus persica, Nectarines Prunus persica var. Nectaria

GEOGRAPHIC PRODUCTION AREAS Western States

1. ACRES PLANTED: 84,300

2. ACRES HARVESTED: 84,300

3. ACRES TREATED: 30%

4. FUNGICIDE fixed coppers

   a. Formulations: various

   b. Federal/State recommendations or guidelines:

Rate (ai/A)	No. of Applications	Timing range or avg.
2 - 4 lbs	2	fall

   c. Methods of application: Air blast

   d. Diseases subject to control:

Common Name	Causal Organism	% Acres Infected	% Yield Loss Without Control
Peach-leaf curl	Taphrina deformans	80	25-30
Shot hole	Stigmina carpophila	25	proportional to twig dieback

   e. Normal (appropriate or typical) management practices using chemical and non-chemical control: Fall application of fixed copper with follow-up application in January if rain periods heavy.

   f. Alternative fungicides: Chlorothalonil, ziram

5. DISEASE MANAGEMENT STRATEGIES:

   a. Resistance management: None

   b. Management practices using no chemical pesticides: None

   c. Diseases without adequate controls:

FUNGICIDE BENEFITS REPORT

COMMODITY Peaches Prunus persica, Nectarines Prunus persica var. Nectaria

GEOGRAPHIC PRODUCTION AREAS Western States

1. **ACRES PLANTED:** 84,300

2. **ACRES HARVESTED:** 84,300

3. **ACRES TREATED:** 30%

4. **FUNGICIDE** ziram

   a. **Formulations:** 80WP

   b. **Federal/State recommendations or guidelines:**

Rate (ai/A)	No. of Applications	Timing range or avg.
1-2 lb	1-2	fall/spring

   c. **Methods of application:** Ground rig, air blast

   d. **Diseases subject to control:**

Common Name	Causal Organism	% Acres Infected	% Yield Loss Without Control
Shot hole	Stigmina carpophila	25	proportional to twig dieback

   e. **Normal (appropriate or typical) management practices using chemical and non-chemical control:** Fall application of ziram with follow-up application in January if rain periods heavy.

   f. **Alternative fungicides:** chlorothalonil, copper

5. DISEASE MANAGEMENT STRATEGIES:

   a. **Resistance management:** none

   b. **Management practices using no chemical pesticides:** none

   c. **Diseases without adequate controls:**

Fungicide Benefits on PEAR (*Pyrus communis*)

Pear production in the United States is about 934,000 tons produced on 69,600 acres, 90% of which is located in the western states of California, Oregon, and Washington. In the east, commercial pear Production is limited to relatively few states with 5,800 acres being grown in Michigan, New York, and Pennsylvania (Table 12). Fireblight, a bacterial disease, is a major limiting factor in pear production since most cultivars are susceptible to moderate to severe damage when infection occurs. It is favored by warm humid conditions and for this reason pears are not grown commercially in eastern states south of Pennsylvania.

The control of fireblight requires the use of cultural practices which are carefully balanced along with specifically timed applications of streptomycin during and after bloom. Control in some northcentral orchards has been difficult to maintain due to development of streptomycin-resistant strains of the pathogen. Other fungal diseases of importance in eastern orchards include pear scab, Fabraea spot, sooty blotch, and fly speck which either deforms or blemishes fruit or defoliates the tree. Their control is dependent on fungicide applications during the post-bloom period. Fungicides most commonly used are ferbam, ziram, fenarimol, or a combination of benomyl with ferbam or ziram. With the recent loss of registration of captan and benomyl (for post-harvest disease control) the control of pathogens causing decay of fruit before and after harvest is of major concern to growers. Ferbam and ziram have low efficacy levels against black rot, bitter rot, and blue mold.

Table 12. All Pears Bearing Acres and Production in the United States by Regions.

State/Region	Bearing Acres-1988	Production Tons
Northeast		
Connecticut	400	1,650
New York	2,800	17,300
Total	3,200	18,950
NorthCentral		
Michigan	1,500	8,000
Total	1,500	8,000
Mid-Atlantic		
Pennsylvania	1,100	3,200
Total	1,100	3,200
West		
California	22,400	303,000
Colorado	700	3,800
Oregon	16,900	225,000
Utah	400	2,000
Washington	23,400	370,000
Total	63,800	903,800
Total U.S.	69,600	933,950

FUNGICIDE BENEFITS REPORT

COMMODITY Pears Pyrus communis

GEOGRAPHIC PRODUCTION AREAS Western States

1. ACRES PLANTED: 63,800

2. ACRES HARVESTED: 63,800

3. ACRES TREATED: 1 - 60%

4. FUNGICIDE Benomyl

   a. Formulations: Benlate 50W, 50DF

   b. Federal/State recommendations or guidelines:

Rate (ai/A)	No. of Applications	Timing range or avg.
2-3 oz/100g/1.0-4.0 lbs.	1	post-harvest

   c. Methods of application: Dip (blue mold, grey mold) Greentip bloom, post bloom airblast sprays for scab and powdery mildew.

   d. Diseases subject to control:

Common Name	Causal Organism	% Acres Infected	% Yield Loss Without Control
Powdery mildew	Podosphaera leucotricha	0-1	0
Blue mold Bull's eye rot	Penicillium expansum	postharvest rot	50
Grey mold	Botrytis cinerea	postharvest rot	50
Scab	Venturia pirina	25-50	10-30% for fresh market

   e. Normal (appropriate or typical) management practices using chemical and non-chemical control: Post harvest dips to control fruit rot spring foliar applications to control powdery mildew, Botrytis and scab.

   f. Alternative fungicides: Captan, mancozeb, ziram, TBZ, ziram, captan, fenarimol, myclobutanil

5. DISEASE MANAGEMENT STRATEGIES:

a. **Resistance management:** None

b. **Management practices using no chemical pesticides:**
c. **Diseases without adequate controls:** mucor, blue mold, grey mold, fireblight

FUNGICIDE BENEFITS REPORT

COMMODITY Pears Pyrus communis

GEOGRAPHIC PRODUCTION AREAS Western States

1. ACRES PLANTED: 63,800

2. ACRES HARVESTED: 63,800

3. ACRES TREATED: 25%

4. FUNGICIDE Captan

   a. Formulations:

   b. Federal/State recommendations or guidelines:

Rate (ai/A)	No. of Applications	Timing range or avg.
1.0-4.0 lbs	1 - 2	bloom - 2nd cover

   c. Methods of application: Ground rig, air blast

   d. Diseases subject to control:

Common Name	Causal Organism	% Acres Infected	% Yield Loss Without Control
Grey mold	Botrytis cinerea	Postharvest	50
Scab	Venturia pirina	25 - 50	10-30 Fresh Mkt

   e. Normal (appropriate or typical) management practices using chemical and non-chemical control:

   f. Alternative fungicides: Benomyl, dodine, ferbam, sulfur, ziram, mancozeb, fenarimol, myclobutanil

5. DISEASE MANAGEMENT STRATEGIES:

   a. Resistance management: None

   b. Management practices using no chemical pesticides: None

   c. Diseases without adequate controls:Fireblight, mucor

FUNGICIDE BENEFITS REPORT

COMMODITY Pears Pyrus communis

GEOGRAPHIC PRODUCTION AREAS Western States

1. **ACRES PLANTED:** 63,800

2. **ACRES HARVESTED:** 63,800

3. **ACRES TREATED:** 90%

4. **FUNGICIDE** Copper

   a. **Formulations:** Kocide 101, Copper Count N

   b. **Federal/State recommendations or guidelines:**

Rate (ai/A)	No. of Applications	Timing range or avg.
4 lbs	3-8	bloom, end of bloom

   c. **Methods of application:** Air blast, ground

   d. **Diseases subject to control:**

Common Name	Causal Organism	% Acres Infected	% Yield Loss Without Control
Fire blight	Erwinia amylovora	100	100

   e. **Normal (appropriate or typical) management practices using chemical and non-chemical control:** Spray initiation based on average temperature of 62° F in March - May. Sprays applied every 4-5 days, thereafter, to end of bloom.

   f. **Alternative fungicides:** Terramycin, Streptomycin Sulfate

5. DISEASE MANAGEMENT STRATEGIES:

   a. **Resistance management:** Resistance to copper unknown

   b. **Management practices using no chemical pesticides:** None

   c. **Diseases without adequate controls:** Fire blight, fruit rots.

FUNGICIDE BENEFITS REPORT

COMMODITY Pears Pyrus communis

GEOGRAPHIC PRODUCTION AREAS Western States

1. ACRES PLANTED: 63,800

2. ACRES HARVESTED: 63,800

3. ACRES TREATED: 6%

4. FUNGICIDE Mancozeb

a. Formulations: 200F, 2.4E, 80N

b. Federal/State recommendations or guidelines:

Rate (ai/A)	No. of Applications	Timing range or avg.
2.7-3.6 lb.	2-3	dormant

c. Methods of application: Ground rig, blower

d. Diseases subject to control:

Common Name	Causal Organism	% Acres Infected	% Yield Loss Without Control
Grey mold	Botrytis cinera	100	50

e. Normal (appropriate or typical) management practices using chemical and non-chemical control:

f. Alternative fungicides: Captan, ziram, sodium orthophenylphenate, thiabendazole.

5. DISEASE MANAGEMENT STRATEGIES:

a. Resistance management: None

b. Management practices using no chemical pesticides: None

c. Diseases without adequate controls: Fire blight.

FUNGICIDE BENEFITS REPORT

COMMODITY Pears Pyrus communis

GEOGRAPHIC PRODUCTION AREAS Western States

1. **ACRES PLANTED:** 63,800

2. **ACRES HARVESTED:** 63,800

3. **ACRES TREATED:** 90%

4. **FUNGICIDE** Streptomycin sulfate

   a. **Formulations:** Agristrep 21.2WP

   b. **Federal/State recommendations or guidelines:**

Rate (ai/A)	No. of Applications	Timing range or avg.
5-10 oz/A	3-8	bloom, end of bloom

   c. **Methods of application:** Air blast, ground

   d. **Diseases subject to control:**

Common Name	Causal Organism	% Acres Infected	% Yield Loss Without Control
Fire blight	Erwinia amylovora	100	100

   e. **Normal (appropriate or typical) management practices using chemical and non-chemical control:** Spray initiation based on average temperature in March - May. Sprays applied every 4-5 days thereafter until bloom ceases.

   f. **Alternative fungicides:** Copper, Terramycin.

5. DISEASE MANAGEMENT STRATEGIES:

   a. **Resistance management:** Resistance to streptomycin is common in some production areas and managed by limiting number of applications.

   b. **Management practices using no chemical pesticides:** None

   c. **Diseases without adequate controls:** Fire blight, fruit rots.

Fungicide Benefits on PLUMS (*Prunus salicina*) and PRUNES (*Prunus domestica*)

The major plum and prune producing area of the United States is in the western states of California, Oregon, Washington, and Idaho (Table 13). California is the major producer of both plums (40,000 acres) and prunes (75,800) with annual production of 216,000 tons of plums and 155,000 tons of prunes. California produces 88% of the annual national production of these crops. The relatively small amount grown in the eastern states (11,775 tons) is centered in Michigan (2,800 acres) with only a few hundred acres in other eastern states. Both plums and prune-type plums grown in the east are produced for canning and fresh consumption and not for dried prune production.

Brown rot is the major disease in eastern orchards and fungicide sprays are required for control. Sprays must be applied during the blossoming period when rain periods occur and during harvest to protect ripening fruit. Development of resistant strains of this pathogen to the benzimidazole and dicarboximide fungicides is a high probability unless combinations of chemically unrelated companion fungicides are used. In addition to brown rot six other fungal and two bacterial diseases require regular or sporadic use of chemical sprays to prevent economic losses. Black knot is the second most important fungal disease causing destruction to twigs and branches. Most registered fungicides for use on plums are ineffective against black knot or their effectivity is unknown. The registered fungicides most commonly used in plums and prunes include benomyl, captan, chlorothalonil, iprodione, vinclozolin, sulfur, and triforine.

Table 13. Prunes and Plums Bearing Acres and Production in the United States by Regions.

State/Region	Bearing Acres-1988	Production Tons
NorthCentral		
Michigan	2,800	11,800
Total	2,800	11,800
West		
California	115,800	371,000
Idaho	900	6,500
Oregon	4,300	21,000
Washington	1,500	13,500
Total	122,500	412,000
Total U.S.	125,300	423,800

FUNGICIDE BENEFITS REPORT

COMMODITY Prune and Plums - Prunus salicina and P. domestica

GEOGRAPHIC PRODUCTION AREAS Western States

1. **ACRES PLANTED:** 122,500

2. **ACRES HARVESTED:** 122,500

3. **ACRES TREATED:** 47%

4. **FUNGICIDE** benomyl

   a. **Formulations:** Benlate 50W/50DF

   b. **Federal/State recommendations or guidelines:**

Rate (ai/A)	No. of Applications	Timing range or avg.
.75-1.0 lb	1	bloom

   c. **Methods of application:** Ground rig, air blast

   d. **Diseases subject to control:**

Common Name	Causal Organism	% Acres Infected	% Yield Loss Without Control
Brown rot	Monilinia fructicola	50	5-10
Leaf spot	Coccomyces prunophorae		

   e. **Normal (appropriate or typical) management practices using chemical and non-chemical control:** 1-2 bloom applications

   f. **Alternative fungicides:** captan, DCNA, iprodione, vinclozolin, triforine, ziram

5. DISEASE MANAGEMENT STRATEGIES:

   a. **Resistance management:** tank mix or alternate with captan to combat resistance to benomyl.

   b. **Management practices using no chemical pesticides:** Clean cultivation and removal of mummies.

   c. **Diseases without adequate controls:**

FUNGICIDE BENEFITS REPORT

COMMODITY Prune and Plums - Prunus salicina and P. domestica

GEOGRAPHIC PRODUCTION AREAS Western States

1. ACRES PLANTED: 122,500

2. ACRES HARVESTED: 122,500

3. ACRES TREATED: 18%

4. FUNGICIDE captan

a. Formulations: Captan 50W

b. Federal/State recommendations or guidelines:

Rate (ai/A)	No. of Applications	Timing range or avg.
1-4 lb	1-2	bloom

c. Methods of application: Ground rig, air blast

d. Diseases subject to control:

Common Name	Causal Organism	% Acres Infected	% Yield Loss Without Control
Brown rot	Monilinia fructicola	50	5-10

e. Normal (appropriate or typical) management practices using chemical and non-chemical control: 1-2 bloom applications

f. Alternative fungicides: benomyl, anilazine, vinclozolin, thiram, thiophanate methyl, dodine

5. DISEASE MANAGEMENT STRATEGIES:

a. Resistance management: Generally applied with benomyl.

b. Management practices using no chemical pesticides: Clean cultivation and removal of mummies.

c. Diseases without adequate controls:

FUNGICIDE BENEFITS REPORT

COMMODITY Prune and Plums - Prunus salicina and P. domestica

GEOGRAPHIC PRODUCTION AREAS Western States

1. **ACRES PLANTED:** 122,500

2. **ACRES HARVESTED:** 122,500

3. **ACRES TREATED:** 23%

4. **FUNGICIDE** chlorothalonil

   a. **Formulations:** Bravo 4F

   b. **Federal/State recommendations or guidelines:**

Rate (ai/A)	No. of Applications	Timing range or avg.
2.3-4.21b	1-2	

   c. **Methods of application:** Ground, air blast

   d. **Diseases subject to control:**

Common Name	Causal Organism	% Acres Infected	% Yield Loss Without Control
Brown rot	Monilinia fructicola & milaxa	50	5-10
Leaf spot	Coccomyces prunophorae		

   e. **Normal (appropriate or typical) management practices using chemical and non-chemical control:**

   f. **Alternative fungicides:** captan, iprodione, vinclozolin, triforine, benomyl, sulfur, dodine, ziram

5. DISEASE MANAGEMENT STRATEGIES:

   a. **Resistance management:** None

   b. **Management practices using no chemical pesticides:** None.

   c. **Diseases without adequate controls:**

Fungicide Report on STRAWBERRY (Fragaria virginiana)

Strawberries are grown commercially throughout the United States with an estimated 55,000 acres valued at $1.2 billion. Acreage and production data are not well recorded, and since strawberries are a favorite home garden crop it is likely that the national production is 10%-20% higher than the estimates. Commercial production is similar in both eastern and western regions. In the eastern region production is estimated at 5,600 acres in five northeastern states, 9,500 acres in six northcentral states, and 14,800 acres in 11 southeastern states. Acreage estimates for each eastern state ranges from 300 to 2,500 acres with many states producing 1,000 acres or more.

Eight to ten fungal diseases are common to strawberry production in all regions. Fruit rot caused by Botrytis cinerea is the most prevalent disease affecting all plantings when frequent rain periods occur during harvest. Other fungi causing fruit rot, leaf spots and powdery mildew are present in 15%-35% of the eastern acreage where each disease may produce losses of 5%-45% if not properly controlled. Fungicide sprays applied in 2-5 applications are commonly used to protect leaves and fruit from infections. Control measures other than fungicide applications used by growers include the use of resistant cultivars, straw mulch to protect fruit from contact with the soil, weed control to increase rapid drying of leaves and fruit, and adequate use of irrigation to prevent moisture stress. Additionally, control of several diseases is improved through annual renovation of beds which destroys disease inoculum, and the practice of planting on raised beds eliminates flooding of plants and encourages rapid drying.

Fungicides most commonly used are captan, benomyl, and vinclozolin because they are highly effective against several diseases and can be used near the time of harvest. Other registered fungicides include copper, thiophanate methyl, thiram, and ziram have received only limited usage because of level of efficacy, phytotoxicity, or cost to apply.

FUNGICIDE BENEFITS REPORT

COMMODITY Strawberries - Fragaria virginiana

GEOGRAPHIC PRODUCTION AREAS Western States

1. **ACRES PLANTED:** 42,745

2. **ACRES HARVESTED:** 42,745

3. **ACRES TREATED:** 30-100%

4. **FUNGICIDE** benomyl

   a. **Formulations:** 50W, 50DF

   b. **Federal/State recommendations or guidelines:**

Rate (ai/A)	No. of Applications	Timing range or avg.
0.5-1. lb	6-14	bloom to harvest

   c. **Methods of application:** Ground rig, boom sprayer

   d. **Diseases subject to control:**

Common Name	Causal Organism	% Acres Infected	% Yield Loss Without Control
Powdery mildew	Sphaerotheca macularis sp fragarae	30	30
Leaf spot	Mycosphaerella fragariae	60	5
Leaf blotch	Zythia sp.	20	2
Fruit rot	Botrytis cinerea	100	50
Leaf scorch	Diplocarpon earliana		

   e. **Normal (appropriate or typical) management practices using chemical and non-chemical control:** Fungicides are sprayed at bloom then on two week intervals during wet periods including fog and rain.

   f. **Alternative fungicides:** captan, anilazine, vinclozolin, thiram, thiophanate methyl, iprodione. Vinclozolin and iprodione not effective against leaf spot, Rhizopus fruit rot.

5. DISEASE MANAGEMENT STRATEGIES:

a. **Resistance management**: High levels of resistance to benomyl, vinclozolin and iprodione-latter 2 fungicides are restricted to 4 and 6 applications respectively and use of only one of the two in any one year. Tank mix any of the three with captan, anilazine or thiram.

b. **Management practices using no chemical pesticides**: sanitation.

c. **Diseases without adequate controls**:

FUNGICIDE BENEFITS REPORT

COMMODITY Strawberries - Fragaria virginiana

GEOGRAPHIC PRODUCTION AREAS Western States

1. **ACRES PLANTED:** 42,745

2. **ACRES HARVESTED:** 42,745

3. **ACRES TREATED:** 54-95%

4. **FUNGICIDE** captan

   a. **Formulations:** 50WP, F

   b. **Federal/State recommendations or guidelines:**

Rate (ai/A)	No. of Applications	Timing range or avg.
2-3 lb	6-14	early bloom-harvest

   c. **Methods of application:** Ground rig, boom sprayer

   d. **Diseases subject to control:**

Common Name	Causal Organism	% Acres Infected	% Yield Loss Without Control
Leaf Spot	Mycosphaerella fragariae	100	5
Grey mold fruit rot	Botrytis cinerea	100	50
Leaf scorch	Diplocarpon earliana	20	2
Leaf blotch	Zythia sp.	20	2

   e. **Normal (appropriate or typical) management practices using chemical and non-chemical control:** Fungicides are applied at bloom and as required depending on rain and fog events throughout the season.

   f. **Alternative fungicides:** benomyl, dodine, anilazine, thiram, vinclozolin, iprodione. Latter two products not effective against leaf spot or Rhizopus fruit rot.

5. DISEASE MANAGEMENT STRATEGIES:

a. **Resistance management:** Tank mix benomyl, iprodione, vinclozolin with captan or thiram.

b. **Management practices using no chemical pesticides:** weed control, frequent picking, do not use overhead irrigation or over-fertilize

c. **Diseases without adequate controls:**

FUNGICIDE BENEFITS REPORT

COMMODITY Strawberries - Fragaria virginiana

GEOGRAPHIC PRODUCTION AREAS Western States

1. **ACRES PLANTED:** 42,745

2. **ACRES HARVESTED:** 42,745

3. **ACRES TREATED:** 100%

4. **FUNGICIDE** Sulfur

   a. **Formulations:** 50W-80DF

   b. **Federal/State recommendations or guidelines:**

Rate (ai/A)	No. of Applications	Timing range or avg.
2.5-5.0 lb	5-12	spring-harvest

   c. **Methods of application:** Ground rig, boom sprayer

   d. **Diseases subject to control:**

Common Name	Causal Organism	% Acres Infected	% Yield Loss Without Control
Powdery mildew	Sphaerotheca macularis f sp fragarae	80	35

   e. **Normal (appropriate or typical) management practices using chemical and non-chemical control:** Sulfur is applied for powdery mildew control beginning in the spring. Applications are made as needed to suppress disease.

   f. **Alternative fungicides:** Myclobutanil - nursery only (24c)

5. DISEASE MANAGEMENT STRATEGIES:

   a. **Resistance management:** None

   b. **Management practices using no chemical pesticides:** None

   c. **Diseases without adequate controls:**